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Morphological and molecular evidence supports *Argiope chloreis* Thorell 1877 and *A. chloreides* Chrysanthus 1961 (Araneidae: Argiopinae) as distinct species

Ji Tan[1*], Zi-Yang Chan[2], Chun-Xing Wong[3], Joseph Koh Kok-Hong[4] & Hoi-Sen Yong[5]

[1]*Department of Agricultural and Food Sciences, Universiti Tunku Abdul Rahman (UTAR), 31900 Kampar, Perak, Malaysia*
E-mail: jtan@utar.edu.my
[2]*School of Pharmacy, Faculty of Science, University of Nottingham Malaysia Campus, Jalan Broga, 43500, Semenyih, Malaysia*
[3]*School of Social Sciences, Faculty of Humanities Arts and Heritage, Universiti Malaysia Sabah, Jalan UMS, 88400 Kota Kinabalu, Sabah, Malaysia*
[4]*National Biodiversity Center, National Parks Board, 1-B, Cluny Road, 259598, Singapore*
[5]*Institute of Biological Sciences, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia*
** Corresponding author*

Abstract — The two green-bodied *Argiope chloreis* Thorell 1877 and *A. chloreides* Chrysanthus 1961 from Southeast Asia were shown to be distinct species on the basis of morphological and multi-gene data analyses. The two species recorded interspecific uncorrected p-distances of 7.87−8.83% and 8.21−9.18% based on COI and COII datasets, respectively. Individuals of *A. chloreis* from Peninsular Malaysia and East Malaysia are considered to be conspecific based on the relatively low intraspecific p-distance as well as similarities in their epigynal structure. Phylogenetic analysis of the COI+COII+H3A dataset has demonstrated that *A. chloreis* and *A. chloreides* are sister to each other, and related to *A. aemula* (Walckenaer 1841) and *A. anasuja* Thorell 1877. The morphological and genetic characteristics of male *A. chloreides* were described for the first time.

Key words — Green, morphology, molecular, taxonomy, multigene, DNA

Introduction

The genus *Argiope* (Araneidae, orb-weavers) shows a cosmopolitan distribution and exhibit a prominent sexual dimorphism featuring colorful females with unique web decorations. The genus is currently comprised of 88 taxonomically accepted species (World Spider Catalog 2019). The taxonomy of *Argiope* spiders is well-documented following the comprehensive study by Levi (1983; 2004), and Bjørn (1997). Jäger (2012) has further introduced the use of broken emboli in female specimens as a useful method in *Argiope* species identification. These notable works have facilitated numerous research studies on this genus, including species descriptions and synonymies, molecular and biogeographic analyses (Cheng et al. 2009; Cheng & Kuntner 2014; 2015; Tan et al. 2016; Agnarsson et al. 2016; Tan 2018).

Argiope chloreis Thorell 1877 is a small-sized *Argiope* species (total length ≤ 8.5 mm) first reported from Kendari, Sulawesi (then Celebes). Thorell (1877) described the penultimate female *A. chloreis* holotype as displaying an ovate, greenish-grey abdomen with dorsal marginal white lines. On the dorsum of the abdomen were 6-8 sigilla arranged in multiple transverse rows of two, while the venter featured a median rectangular white area, bordered on each side by a dark narrow, broken longitudinal line (Thorell 1890; Chrysanthus 1961; Levi 1983). This was followed by the description of *A. pumila* Thorell 1890 based on an adult female specimen from Padang, Sumatra, Indonesia. *A. pumila* was morphologically very similar to *A. chloreis* except for the multiple transverse white lines present near the sigilla of the abdomen. 71 years later, a female *Argiope chloreides* was decribed by Chrysanthus (1961) as a new species from New Guinea that is distinct from both *A. chloreis* and *A. pumila*. *A. chloreides* was reported to have a slender greenish-grey abdomen that is dorsally reticulated and "almost without a distinct pattern" (fig. 5, p. 197 in Chrysanthus 1961), while there was an absence of spines on tibia I and II. The epigyna of *A. chloreides* and *A. pumila* (figs. 7 & 11, p. 197 in Chrysanthus 1961) were different in shape in posterior view but they both feature lateral extensions from the posterior plate. Nevertheless, Levi (1983) synonymized *A. chloreides* and *A. pumila* to *A. chloreis*, citing the lack of distinctive morphological difference between these three taxa. However, Levi (1983) reported that some morphological features, i.e. abdominal patterns and tibial spines, had faded or were lost in the holotype or syntype specimens. Furthermore, there was a complete lack of any male specimens in collections. Our recent collection of more *Argiope* "*chloreis*" specimens has revealed some discrepancies in the taxonomy of *A. chloreis* and *A. chloreides*. Hence, the present study aims to evaluate

the taxonomic status of *A. chloreis* and *A. chloreides* based on morphological and molecular data. The phylogenetic relationships of these two species were investigated. A male specimen of *A. chloreides* was also described for the first time.

Materials and Methods

Ethics Statement

The research on *Argiope* spiders was approved by the Universiti Tunku Abdul Rahman (UTAR) Scientific and Ethical Review Committee (SERC) and was conducted in accordance to the guidelines stated by SERC.

Field Sampling

Specimens were mostly photographed in the field using a Nikon D800 to record natural body coloration. All specimens were photographed by Tan J. unless otherwise stated. Two legs of each specimen were preserved in 95% ethanol for DNA extraction, while the specimen itself was preserved in 75% ethanol. All voucher specimens were deposited in the UTAR Zoological Collection (UZC) of UTAR, Kampar, Perak, Malaysia.

Sample Examination

Morphological examination of specimens was performed using a Motic SMZ-161 stereomicroscope and a Labo AXL microscope. The specimens were identified based on Thorell (1877), Chrysanthus (1961), Jäger (2012), as well as the detailed re-description by Levi (1983). Measurements were taken following calibration via Motic Image Plus 2.0. Higher resolution photos were taken using a mounted Samsung Galaxy S7 Edge. Line drawings were digitally traced using a Wacom Bamboo CTL471 tablet. The format of morphological description is based on Jäger & Praxaysombath (2009) and Ono (2010), with terminology according to Levi (1983) and Bjørn (1997). Leg and palp measurements were shown as: total length (femur, patella, tibia, metatarsus, tarsus).

Abbreviations: AME, anterior median eyes; ALE, anterior lateral eyes; AW, anterior width of dorsal shield of prosoma; OL, length of opisthosoma; OW, width of opisthosoma; PME, posterior median eyes; PL, length of dorsal shield of prosoma; PLE, posterior lateral eyes; PW, width of dorsal shield of prosoma.

DNA Extraction and Amplification

Specimen DNA was extracted from preserved leg specimens using an i-genomic G-Spin Total DNA Extraction Kit (iNtRON Biotechnology, Korea).

The present study employed the use of the cytochrome *c* oxidase subunit 1 (COI), cytochrome *c* oxidase subunit 2 (COII), 16S ribosomal DNA (16S), histone H3 family A (H3A) and 18S ribosomal DNA (18S) molecular markers for analyses. The mitochondrial (COI, COII and 16S) and nuclear (H3A and 18S) markers were amplified with PCR using a FlexCycler2 PCR machine (Analytik Jena, Germany) and i-Taq™ Plus DNA Polymerase Kits (iNtRON Biotechnology, Korea). The primer sets and PCR parameters used were based on Tan (2018). PCR amplicons were subjected to a 1.0% agarose gel electrophoresis stained with Gelred (Invitrogen, USA) prior to visualization. Desired amplicons were purified and sequenced by Genomics Bioscience & Technology.

Molecular Analyses

The DNA contigs of each sequenced sample were assembled using ChromasPro V1.5 (Technelysium Pty Ltd). Currently available DNA sequences of other *Argiope* spp. from across the globe (Cheng & Kuntner 2014; 2015; Tan et al. 2016; Tan 2018) were included for comparison (Table 1) while DNA sequences of doubtful identity were omitted. The genera *Gea* C. L. Koch 1843 and *Neogea* Levi 1983 were incorporated to fully represent the subfamily of Argiopinae in these analyses. *Cyrtophora* and *Gasteracantha* were selected as outgroup taxa for all phylogenetic analyses as they were shown to be closely related to Argiopinae and resided within the "argiopoid clade" based on the cladistic analysis by Scharff & Coddington (1997) and molecular phylogenetics by Cheng & Kuntner (2014; 2015).

The construction of multiple sequence alignment blocks of each DNA marker as well as concatenated markers was performed using default MUSCLE parameters at https://www.ebi.ac.uk/Tools/msa/muscle/ (Edgar 2004) and Bioedit v7.2.5 (Hall 1999). Only species with a complete set of DNA sequences for each marker were considered for concatenated datasets. File conversions were carried out using Geneious v11.0.5 (https://www.geneious.com) and ALTER (Glez-Peña 2010).

Phylogenetic trees were inferred for each individual marker and concatenated datasets using Maximum Likelihood (ML) and Maximum Parsimony (MP) algorithms. The optimal partitioning schemes and substitution models of each dataset were computed using Partition Finder v2.1.1 (Lanfear et al. 2018) based on the corrected Akaike information criterion (AICc). ML analyses were performed using the IQ-TREE web server (Nguyen et al. 2015; Trifinopoulos et al. 2016) available at http://iqtree.cibiv.univie.ac.at/. ML trees were constructed with the best-fit models of substitution for each partition generated using the Auto function in W-IQ-TREE and clade support computed over 5,000 ultrafast bootstrap replicates.

Bayesian Inference (BI) analysis was performed with Mr. Bayes v3.2.6 (Ronquist et al.2012) based on the recommended partitions and substitution models from Partition Finder. The Markov chain Monte Carlo (MCMC) method was performed over two independent runs of 20,000,000 generations with four chains. Phylogenetic trees were sampled every 100th generation. Tracer v1.5 (available at: http://196 tree.-bio.ed.ac.uk/software/tracer/) was used to identify convergence of log likelihood values, in which the first 25% of samples were discarded as burn-in. All phylogenetic trees were visualized and edited using Figtree v1.3.1 (available at : http://tree.bio.ed.ac.uk/software/figtree/).

Uncorrected pairwise genetic distances were estimated using PAUP 4.0b10 (Swofford 2003) to allow genetic comparisons between different species of *Argiope*. Genetic distance matrices were computed for each individual marker

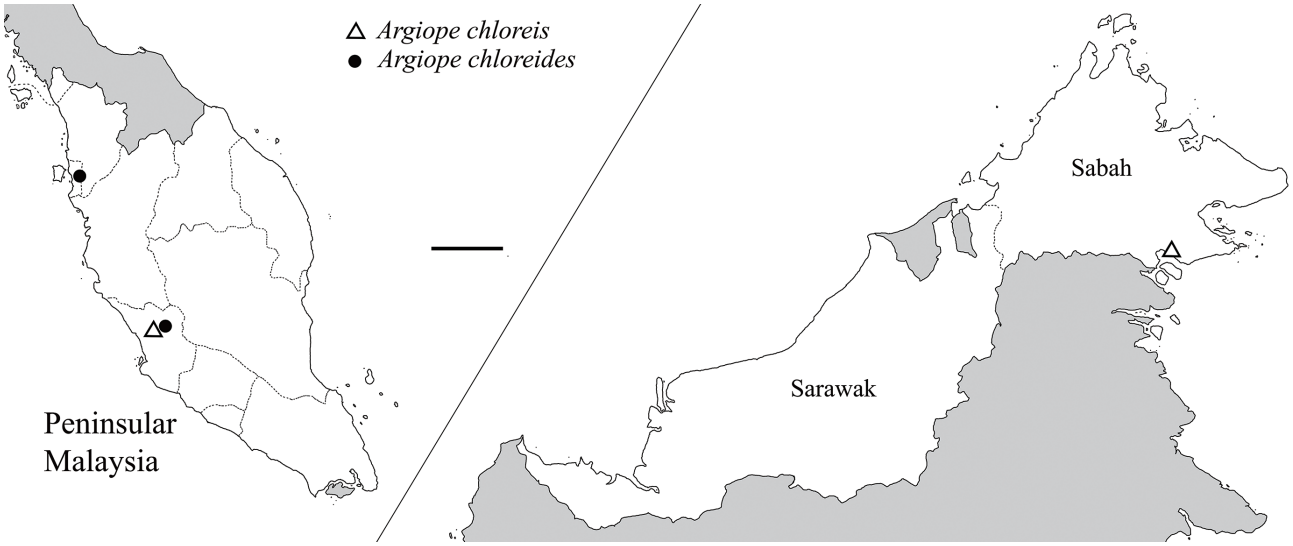


Fig. 1. Sampling locations of *Argiope chloreis* and *A. chloreides* in Malaysia. Scale bar, 100 km.

as well as the COI+COII, COI+COII+H3A and 16S+COI+-COII+H3A+18S datasets.

Results

Eight *Argiope chloreis* (Figs. 3–8) and three *A. chloreides* (Figs. 25–29) specimens were collected and identified in the present study (Table 1) based on descriptions of their respective type materials (Thorell 1877; Chrysanthus 1961; Levi 1983).

Female individuals of *A. chloreis* and *A. chloreides* were morphologically similar in terms of colour and size, but could be distinguished based on (i) the presence of quadrilateral (rectangular to trapezoidal) markings on the dorsal side of the abdomen in *A. chlorides*; and (ii) difference in epiygne structure (details in Taxonomy section). These features were also applicable for specimen ACHLS8 from Sabah with a slightly different abdominal coloration (Fig. 8). Although the morphological description of male *A. chloreides* was not available, the presence of similar quadrilateral markings on the abdomen suggested sample ACHL3 to be *A. chloreides* (which was later supported by molecular data). The taxonomy and natural history of *A. chloreis* and *A. chloreides* are summarized at the end of the manuscript. All specimens were collected from Peninsular Malaysia with the exception of *A. chloreis* ACHLS8 from Sabah, East Malaysia (Fig. 1).

Molecular Analyses

The DNA of the 16S, COI, COII, H3A and 18S genetic markers was successfully amplified and sequenced for all *Argiope chloreis* and *A. chloreides* specimens (Table 1). The final DNA alignment lengths of the 16S, COI, COII, H3A and 18S markers were 459 bp, 521 bp, 414 bp, 336 bp and 874 bp, respectively. These data were used to determine the genetic divergence between *A. chlories* and *A. chloreides*, as well as to infer their phylogenetic relationships within the genus.

Genetic Divergence

The percentage uncorrected p-distances between different species of *Argiope* based on the 16S rDNA, COI, COII, H3A, 18S rDNA and concatenated COI+COII, COI+COII+H3A and 16S+COI+COII+H3A+18S nucleotide sequences are summarized in Table 2. Genetic distance matrices of the COI, COII, and 16S+COI+COII+H3A+18S datasets are shown in Appendices 4, 5 and 6, respectively, while others are available upon request. With the exception of the 18S rDNA, the uncorrected interspecific p-distance recorded by these datasets were many times larger than the intraspecific p-distance although overlaps in inter- and intraspecific p-distances were observed in most datasets. However, these overlaps were removed when *A. chloreis* ACHLS8 was excluded from the analysis. With the exclusion of *A. chloreis* ACHLS8, the uncorrected interspecific p-distances of COI and COII (Appendices 4 & 5) were almost similar at 4.03−16.84% and 3.863−16.18%, respectively while their intraspecific p-distances were 0−0.77% and 0−1.21%, respectively. The interspecific p-distance for the COI+COII nucleotide sequences ranged from 4.39−15.61% while the intraspecific p-distance was 0−4.17%. The interspecific and intraspecific p-distance for the combined COI+COII+H3A sequences recorded ranges of 3.46−12.35% and 0.08−3.23%, respectively. Lastly, the interspecific p-distance for the concatenated 16S+COI+COII+H3A+18S sequences (Appendix 6) ranged from 2.81−6.81% while the intraspecific p-distance range from 0.04−1.54%.

The intra- and interspecific uncorrected p-distance of *Argiope chloreis* and *A. chloreides* is summarized in Table 3. The interspecific p-distances between these two species were much higher than their intraspecific p-distances based on

Table 1. Details of samples used in this study

No.	Species	Voucher	Sex	Details	Genetic Marker				
					16S	COI	COII	H3A	18S
1	*Argiope chloreis*	ACHLS1	F	Ulu Yam, Selangor, Malaysia	MN043976	MN046939	MN046950	MN046961	MN043965
2		ACHLS2	F	Ulu Yam, Selangor, Malaysia	MN043977	MN046940	MN046951	MN046962	MN043966
3		ACHLS3	F	Ulu Yam, Selangor, Malaysia	MN043978	MN046941	MN046952	MN046963	MN043967
4		ACHLS4	F	Ulu Yam, Selangor, Malaysia	MN043979	MN046942	MN046953	MN046964	MN043968
5		ACHLS5	F	Ulu Yam, Selangor, Malaysia	MN043980	MN046943	MN046954	MN046965	MN043969
6		ACHLS6	F	Ulu Yam, Selangor, Malaysia	MN043981	MN046944	MN046955	MN046966	MN043970
7		ACHLS7	F	Ampang, Kuala Lumpur, Malaysia	MN043982	MN046945	MN046956	MN046967	MN043971
8		ACHLS8	F	Mata Chinta, Tawau, Sabah, Malaysia	MN043983	MN046946	MN046957	MN046968	MN043972
9	*Argiope chloreides*	ACHL1	F	Tokun Hill, Penang, Malaysia	KU055666	KU055761	KU055950	KU055856	MG015849
10		ACHL2	F	Semenyih, Selangor, Malaysia	MN043974	MN046937	MN046948	MN046959	MN043963
11		ACHL3	M	Ulu Yam, Selangor, Malaysia	MN043975	MN046938	MN046949	MN046960	MN043964
	GenBank Sequences								
12	*Argiope aemula*	AAEM1	F	Genting Highlands, Pahang, Malaysia	KU055652	KU055748	KU055936	KU055843	MG015847
13	*Argiope aemula*	-	-	Taiwan	-	KJ957938	KJ958038	KJ957993	-
14	*Argiope aetherea*	-	-	Australia	-	KJ957939	KJ958039	KJ957994	-
15	*Argiope aetheroides*	-	-	Taiwan	-	KJ957940	KJ958040	KJ957995	-
16	*Argiope ahngeri*	-	-	Turkey	-	KJ957948	KJ958048	KJ957999	-
17	*Argiope amoena*	-	-	Japan	-	KJ957941	KJ958041	-	-
18	*Argiope anasuja*	-	-	India	-	KJ957942	KJ958042	KJ957996	-
19	*Argiope argentata*	-	-	Puerto Rico	-	KJ957947	KJ958047	KJ957998	-
20	*Argiope aurocincta*	-	-	South Africa	-	KJ957949	KJ958049	-	-
21	*Argiope australis*	-	-	South Africa	-	KJ957951	KJ958051	KJ958001	-
22	*Argiope blanda*	-	-	Costa Rica	-	KJ957952	KJ958052	KJ958002	-
23	*Argiope catenulata*	ACAT1	F	Batu Gajah, Perak, Malaysia	KU055660	KU055755	KU055944	KU055850	MG015848
24	*Argiope dang*	ADAN1	F	Langkap, Perak, Malaysia	KU055667	KU055762	KU055951	KU055857	MG015850
25	*Argiope dang*	-	-	Laos	-	KJ957960	KJ958061	KJ958008	-
26	*Argiope dang*	-	-	Singapore	-	KJ957974	KJ958072	KJ958022	-
27	*Argiope doleschalli*	ADOL1	F	Semenyih, Selangor, Malaysia	KU055676	KU055771	KU055960	KU055866	MG015851
28	*Argiope flavipalpis*	-	-	South Africa	-	KJ957962	KJ958062	KJ958010	-
29	*Argiope hoiseni*	AHOI1	F	Ulu Yam, Selangor, Malaysia	MG015837	MG015871	MG015861	MG015866	MG015842
30	*Argiope jinghongensis*	AJIN9	F	Gunung Jerai, Kedah, Malaysia	MN043984	MN046947	MN046958	MN046969	MN043973
31	*Argiope jinghongensis*	-	-	China	-	KJ957967	KJ958067	KJ958015	-
32	*Argiope keyserlingi*	-	-	Australia	-	KJ957969	KJ958069	KJ958017	-
33	*Argiope levii*	-	-	Mozambique	-	KJ957970	KJ958070	KJ958018	-
34	*Argiope lobata*	-	-	Spain	-	KJ957971	KJ958071	KJ958019	-
35	*Argiope mascordi*	-	-	Australia	-	KJ957975	KJ958073	KJ958023	-
36	*Argiope modesta*	AMOD1	F	Bali, Indonesia	KU055697	KU055792	KU055981	KU055886	MG015854
37	*Argiope modesta*	-	-	Philippines	-	KJ957977	KJ958075	KJ958024	-
38	*Argiope ocyaloides*	-	-	Australia	-	KJ957980	KJ958077	KJ958026	-
39	*Argiope picta*	-	-	Australia	-	KJ957982	KJ958079	KJ958028	-
40	*Argiope pulchella*	APUL1	F	Ulu Yam, Selangor, Malaysia	KU055699	KU055794	KU055983	KU055888	-
41	*Argiope radon*	-	-	Australia	-	KJ957985	KJ958081	KJ958030	-
42	*Argiope ranomafanensis*	-	-	Madagascar	-	KJ957986	KJ958082	KJ958031	-
43	*Argiope reinwardti*	AREI1	F	Cameron Highlands, Pahang, Malaysia	KU055700	KU055795	KU055984	KU055889	MG015855
44	*Argiope submaronica*	-	-	USA	-	KJ957989	KJ958083	KJ958034	-
45	*Argiope trifaciata*	-	-	South Africa	-	KJ957990	KJ958084	KJ958035	-
46	*Argiope versicolor*	AVER1	F	Tokun Hill, Penang, Malaysia	KU055709	KU055804	KU055993	KU055898	MG015856
47	*Gea spinipes*	GSPI1	F	Bukit Gasing, Selangor, Malaysia	KU055736	KU055831	KU056020	KU055925	MG015857
48	*Gea spinipes*	-	-	Taiwan	-	KJ957965	KJ958065	KJ958013	-
49	*Gea theridioides*	-	-	Australia	-	KJ957966	KJ958066	KJ958014	-
50	*Neogea nocticolor*	NNOC1	F	Genting Highlands, Pahang, Malaysia	KU055733	KU055828	KU056017	KU055922	MG015858
51	*Cyrtophora moluccensis*	CMOC1	F	Butterworth, Penang, Malaysia	KU055745	KU055840	KU056029	KU055934	MG015859
52	*Gasteracantha kuhlii*	GKUH1	F	Kepong, Selangor, Malaysia	KU055747	KU055842	KU056031	KU055935	MG015860

* GenBank sequences were based on Cheng & Kuntner (2014; 2015), Tan et al. (2016) and Tan (2018).

Table 2. Percentage of uncorrected p-distance matrix within *Argiope* spp. based on 16S, COI, COII, H3A, 18S and concatenated COI+COII, COI+COII+H3A and 16S+COI+COII+H3A+18S nucleotide sequences.

	16S	COI	COII	H3A	18S	COI+COII	COI+COII +H3A	16S+COI+-COII+H3A +18S
Interspecific p-distance	1.54−6.63	4.03−16.84	3.86−16.18	0.30−7.14	0−1.14	4.39−15.61	3.46−12.35	2.81−6.81
Intraspecific p-distance	0−0.44	0−4.22	0−4.11	0−0.60	0	0−6.42	0.08−4.88	0.04−2.46
Intraspecific p-distance excluding ACHLS8	0−0.44	0−0.77	0−1.21	0−0.60	0	0−4.17	0.08−3.23	0.04−1.54

Table 3. Intra- and interspecific percentage of uncorrected p-distance of *Argiope chloreis* and *A. chloreides* based on 16S, COI, COII, H3A, 18S and concatenated COI+COII, COI+COII+H3A and 16S+COI+COII+H3A+18S nucleotide sequences.

	16S	COI	COII	H3A	18S	COI+COII	COI+COII +H3A	16S+COI+-COII+H3A +18S
p-distance within *A. chloreis* (Peninsular Malaysia)	0	0−0.77	0−0.24	0−0.60	0	3.74−4.06	0.08−3.15	0.12−1.54
p-distance between *A. chloreis* (Peninsular Malaysia) and *A. chloreis* (Sabah)	0.44	4.03−4.41	3.86−4.11	0.30−0.60	0	3.96−6.42	2.99−4.88	1.54−2.46
p-distance within *A. chloreides*	0.22−0.44	0.77−1.92	0.24−1.21	0.30−0.60	0	0.54−4.82	0.47−3.70	0.27−1.85
p-distance between *A. chloreis* and *A. chloreides*	0.66−0.88	7.87−8.83	8.21−9.18	0.30−1.19	0	4.49−8.46	3.38−6.54	1.81−3.35

Table 4. Summary of data partitions and substitution models used for phylogenetic inference based on the 16S, CO1, CO2, H3A and 18S markers

DNA Marker	Data Subset	Substitution Model (IQ-TREE)	Substitution Model (MrBayes)
16S	-	TIM2 + F + I + G4	GTR + I + gamma
CO1	Position 1	TN + F + G4	GTR + I + gamma
	Position 2	F81 + F	F81
	Position 3	TN + F + G4	#GTR + gamma
CO2	Position 1	HKY + F + I	HKY + I + gamma
	Position 2	TN + F + G4	GTR + I + gamma
	Position 3	TN + F + G4	GTR + gamma
H3A	Position 1	TIM3e + G4	GTR + gamma
	Position 2	K2P	K2P + I
	Position 3	SYM + I	SYM + I
18S	-	K2P + I	GTR + I + gamma

the COI and COII datasets at 7.87−8.83% and 8.21−9.18%, respectively. These two datasets also recorded a p-distance range of 4.03−4.41% and 3.86−4.11% between the *A. chloreis* from Peninsular Malaysia and sample ACHLS8 from Sabah.

Phylogenetic Analyses

The phylogeny of Argiopinae was inferred based on individual markers (16S rDNA, COI, COII, H3A and 18S rDNA) as well as concatenated markers (COI+COII, COI+-COII+H3A and 16S+COI+COII+H3A+18S). The summary of data partitions and substitution models used for phylogenetic inference is shown in Table 4. The subfamily Argiopinae was inferred to be monophyletic in all datasets using *Cyrtophora* and *Gasteracantha* as outgroup taxa except for 18S and COI+COII. Nevertheless, *Gea* was inferred to be monophyletic in all datasets while *Argiope* was paraphyletic with respect to *Gea* and *Neogea nocticolor*. The COI+-COII+H3A tree best represented the phylogeny *Argiope*, *Gea* and *Neogea* and is illustrated as Fig. 2. The 16S+COI+-COII+H3A+18S tree showing the phylogenetic relationships between all *A. chloreis* and *A. chloreides* specimens collected in the present study is included as Appendix 3. The 16S,

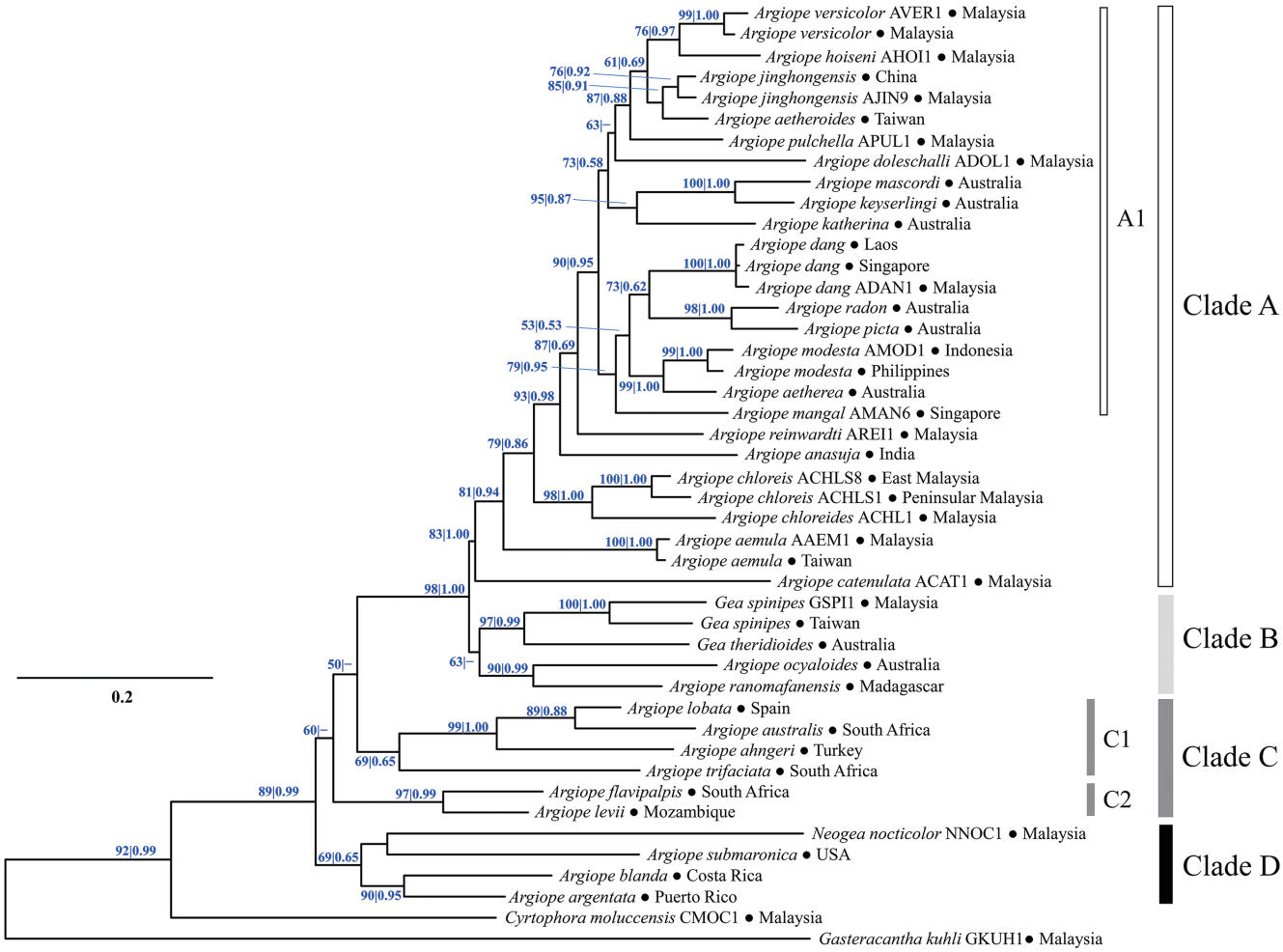


Fig. 2. Maximum Likelihood tree based on the concatenated CO1+CO2+H3A dataset including GenBank sequences. Numeric values at nodes arranged in an order of Ultrafast ML bootstrap support/Bayesian posterior probability.

COI, COII, H3A, 18S and COI+COII trees are available upon request.

Based on the COI+COII+H3A tree (Fig. 2), the monophyletic argiopinae ingroup (ML = 89%; BI = 0.99) consisted of four main clades A–D. Clade D (ML = 69%; BI = 0.65) was comprised of *Argiope* spp. from Americas and *Neogea nocticolor*, while the species from Africa, Europe and the Middle East constituted subclades C1 (ML = 69%; BI = 0.65) and C2 (ML = 97%; BI = 0.99). Clade B consisted of *Gea spinipes, G. theridioides*, *Argiope ocyaloides* and *A. ranomafensis* although the relationship between members of these two genera was weakly supported (ML = 63%). Clade A (ML = 83%; BI = 1.00) consisted of *Argiope* spp. from Asia, with *A. catenulata* forming a sister group to all the other *Argiope* spp. in the clade. *Argiope chloreis* and *A. chloreides* were sister to each other (ML = 98%; BI = 1.00), and collectively formed a sister group (ML = 79%; BI = 0.86) to *A. anasuja*, *A. reinwardti*, and members of subclade A1 (ML = 90%; BI = 0.95), i.e., *A. aetherea*, *A. aetheroides*, *A. dang*, *A. doleschalli*, *A. hoiseni*, *A. jinghongensis*, *A. katherina*, *A. keyserlingi*, *A. mangal*, *A. modesta*, *A. picta*, *A. radon*, *A. mangal*, *A. mascordi*, *A. pulchella* and *A. versicolor*.

Discussion

Taxonomy and phylogeny of *A. chloreis* and *A. chloreides*

Argiope chloreis and *A. chloreides* were shown to different species based on morphology and genetic evidence. Despite the similarities in size and coloration, the morphology of *Argiope chloreis* and *A. chloreides* is clearly different (see Taxonomy section), most notably in their abdominal patterns. The synonymy of these two species by Levi (1983) was likely due to the lack of fresh specimens and the loss of features in the alcohol-preserved specimens. In the present study, specimens of both species were observed to gradually lose their green coloration and bodily setae (which give rise to the silvery-white sheen) when preserved in 80% ethanol.

However, the quadrilateral abdominal markings of both male and female *A. chloreides* remained relatively visible in preservation as opposed to that of *A. chloreis* in which the abdomen became virtually featureless except for the 6−8 pairs of sigillal depressions. This information supported the synonymization of *A. pumila* with *A. chloreis* by Levi (1983). The present study also described the male of *A. chloreides* for the first time. Male individuals appear to display abdominal patterns similar to their female counterparts (Figs. 25, 26 & 29), a similar trait also observed in *A. mangal* (Tan et al. 2016). Considering the close relationship between *A. chloreis* and *A. chloreides*, it is likely that the currently undescribed male specimen of *A. chloreis* would share a similar, virtually featureless abdominal pattern as females of the species.

Argiope chloreis and *A. chloreides* were shown to be genetically different by all genetic markers except H3A and 18S (Table 3), while COI and COII recorded the most notable difference at 7.87−8.83% and 8.21−9.18%, respectively. Genetic variation (COI intraspecific p-distance of ≤ 0.77%; COI ≤ 0.24%) was observed in *A. chloreis* although the majority of the specimens were collected from Selangor, Peninsular Malaysia. Photographic records suggest that the distribution of this species extends southwards to Bekok, Johor. Results of this study have also revealed a marked genetic difference (COI intraspecific p-distance of 4.03−4.41%; COII 3.86−4.11%) between the individuals of *A. chloreis* in Peninsular Malaysia and sample ACHLS8 from Tawau, Sabah, East Malaysia as a result of allopatric speciation. However, this distance is still much lower than the average interspecific p-distance of 10.44 and 10.02 for COI and COII, respectively. Similarities in morphology also suggested that individuals of *A. chloreis* from Peninsular Malaysia and East Malaysia are still conspecific. Although *A. chloreis* ACHLS8 displayed a black-coloured abdominal half (Fig. 8), females without this feature were also observed and it is currently unclear whether the darker coloration is caused by genetics or other extrinsic factors. On the other hand, intraspecific p-distances of 0.77−1.92% and 0.24−1.21% were recorded between individuals of *A. chloreides* based on the COI and COII nucleotide sequences, respectively. Although the sampling of *A. chloreis* and *A. chloreides* was carried out in Malaysia, the inclusion of specimens from the neighbouring islands where they are also reported, e.g. Sumatra, Sulawesi or New Guinea would likely offer useful information on evolutionary patterns and phylogeography (Thorell 1890; Chrysanthus 1961; Levi 1983).

In terms of phylogeny (Fig. 2), *Argiope chloreis* and *A. chloreides* formed a sister group with each other (ML = 98%; BI = 1.00), which is consistent with their unique green coloration- an apomorphic character in *Argiope*. *A. chloreis* and *A. chloreides* were inferred to be related to *A. aemula* and *A. catenulata*, which is in agreement with morphological similarities observed between the females of these species, i.e., oval-shaped abdomen and thick epigynal rims with broad posterior plates (figs. 29−31 and 36−38, p. 275 in Levi 1983). The male palp of *A. aemula* (fig. 35 in Levi 1983) and *A. chloreides* also share a similar median apophysis connected to a short, thorn-like spur although the embolus of the latter species was more well-developed. *Argiope chloreis* and *A. chloreides* formed a sister group to *A. anasuja*, *A. reinwardt*i and a majority of other *Argiope* spp. (ML = 79%; BI = 0.86) within the *A. aetherea* species group defined by Levi (1983) as species with highly specialized reproductive structures. Hence, the evolution of shield-shaped abdomen could be viewed a derived trait in *Argiope* species in Asia and Australia. The inferred relatedness between *A. chloreis*, *A. chloreides* and *A. anasuja* was also evident in similarities of their epigynal structures, with the laterally-extended posterior plates (figs. 167−169, p. 295 in Levi 1983) of *A. anasuja* being less well-developed. The male pedipalps of *A. anasuja* (fig. 172, p. 295 in Levi 1983) also bear some resemblance to that of *A. chloreides* (Figs. 40−41) in terms of the embolus, median apophysis and conductor and differ mainly in the orientation of the embolus tip, as well as the presence of a pendant and filamentous spur.

In conlusion, the present study demonstrated the difference between *Argiope chloreis* and *A. chloreides* based on morphology and molecular data, thereby removing the synonymy of *A. chloreides* from *A. chloreis*. Individuals of *A. chloreis* from Peninsular Malaysia and specimen ACHLS8 from East Malaysia were considered as being conspecific based on the relatively low intraspecific p-distance as well as the lack of clear morphological differences in epigynal structure between the two. The morphology of the male *A. chloreides* was also described.

Taxonomy

Argiope chloreis Thorell 1877
(Figs. 3−24)

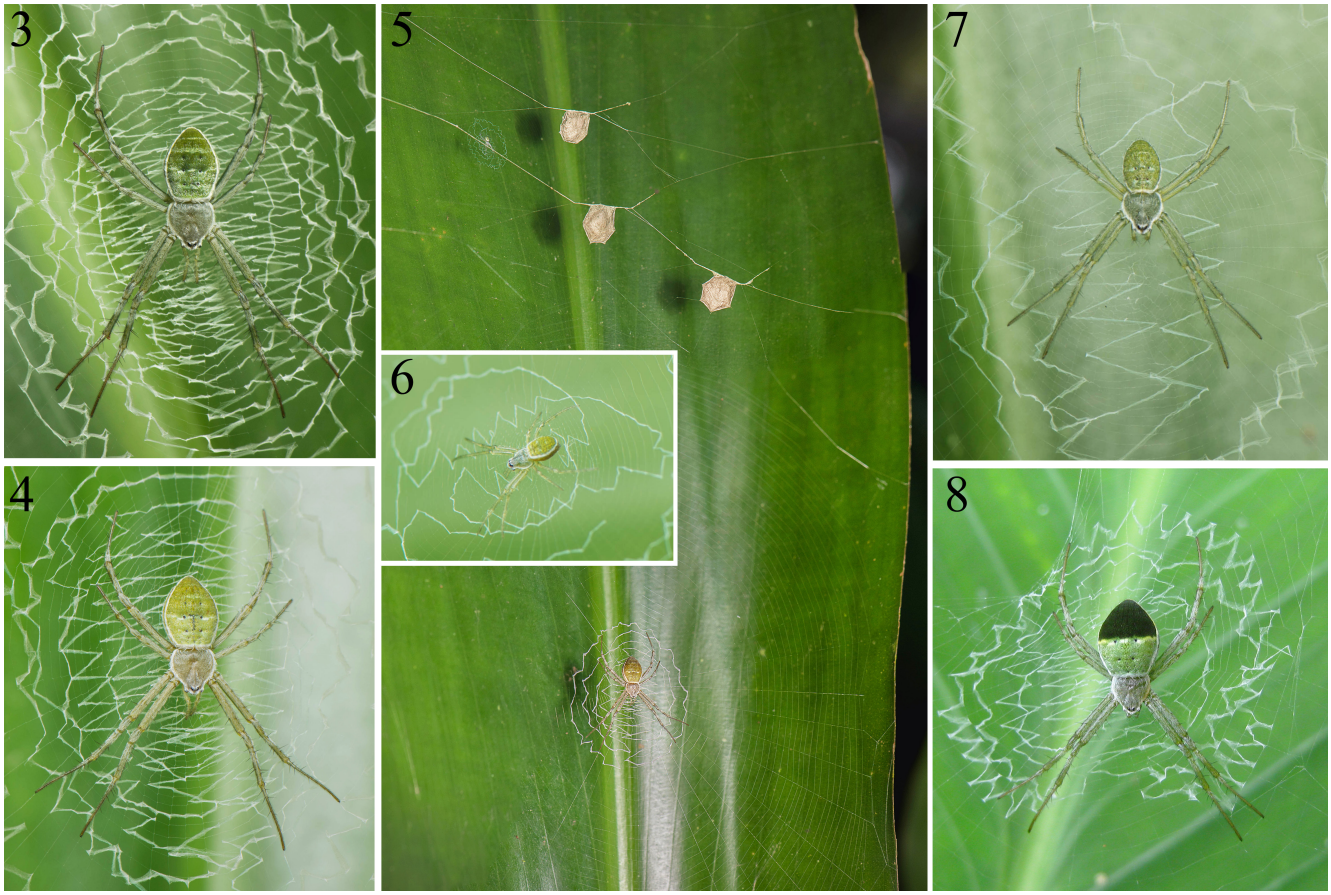
Argiope chloreis Thorell 1877, p. 368. *Argiope chloreis* Levi 1983, p. 291, figs. 144, 145, 148−151.

Argiope pumila: Thorell 1890, p. 99. Chrysanthus 1961, p. 197, figs. 10-11.

Materials examined. MALAYSIA: 1 ♀ (ACHLS1; reg. MZC181014-01), Sungai Tua, Ulu Yam, Selangor, 18.X.2014, Tan J., 18 Oct. 2014; 4 ♀ (ACHLS2−6; reg. MZC040616-01−04), same locality, 4.VI.2016, Tan J.; 1 ♀ (ACHLS7; reg. MZC150616-01), Ampang, Kuala Lumpur, 15.VI.2016, Tan J.; 1 ♀ (ACHLS8; reg. MZC060418-01), near Mata Chinta town, Tawau, Sabah, 04.IV.18, Wong C. X.

Diagnosis. This species bears a resemblance to *Argiope chloreides* Chrysanthus 1961 in terms of its small size (~6 cm body length) and green coloration. Female individuals of this species can be identified based on: (i) thin white borders on dorsal opisthosoma without trapezoidal markings; and (ii) the squarish epigyne in posterior view with a relatively thicker septum and rim, larger depressions and well-developed posterior lips that extend laterally from the posterior plate (Figs. 13 & 21).

Description. Female (ACHLS3, Peninsular Malaysia).



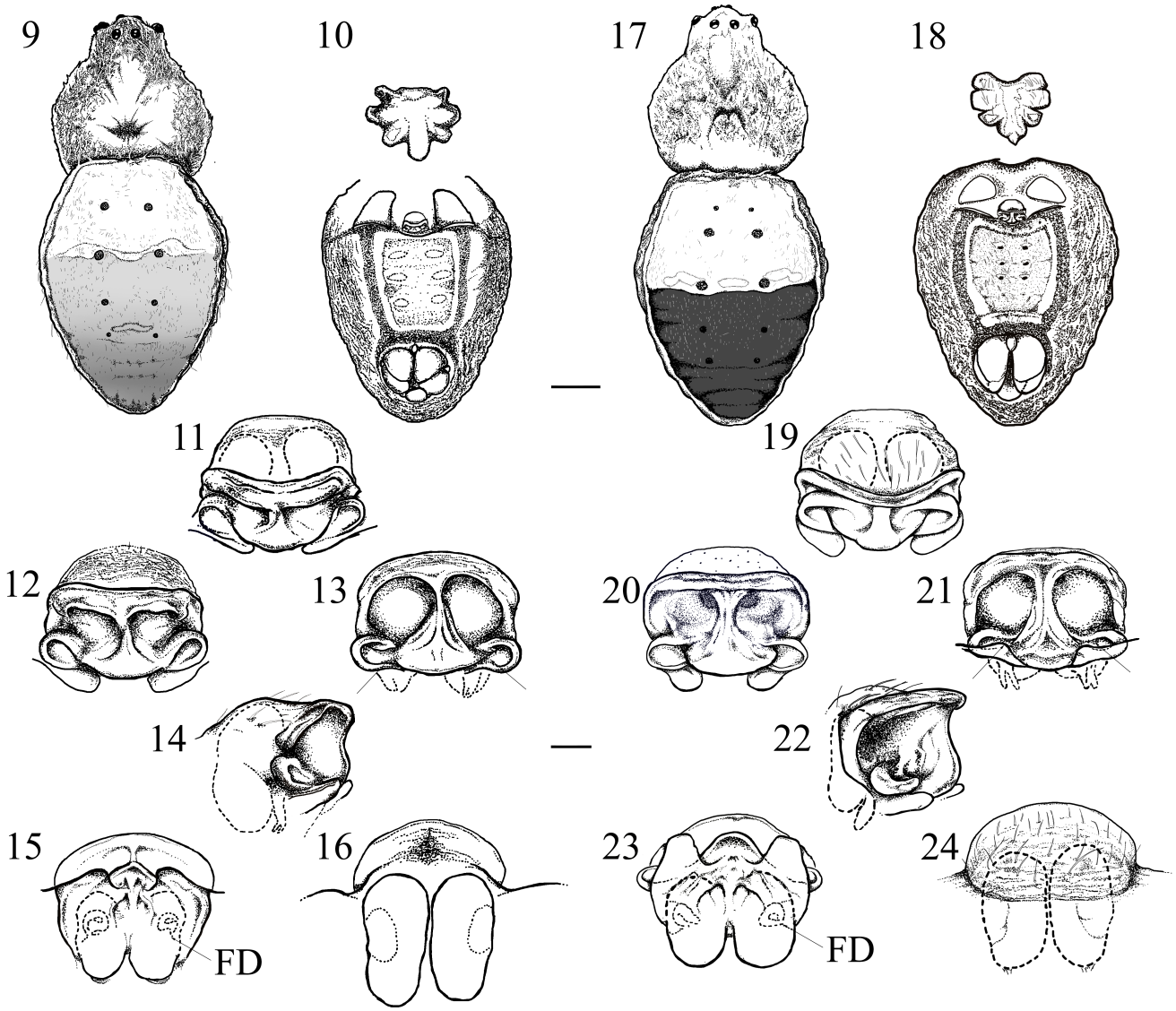
Figs. 3–8. *Argiope chloreis* Thorell 1877 female habitus. 3–4. Different colour morphs of adult females in Peninsular Malaysia; 5. Female in a web with lace-type decorations and multiple egg sacs at the edges; 6. Spiderling; 7. Juvenile female; 8. Adult female (ACHLS8) from Sabah (East Malaysia) with a black abdominal half. Photographs 3–7 by Tan J; 8 by Wong CX.

PL 2.7, PW 2.3, OL 4.0, OW 2.9. Eye diameters and interdistances: AME 0.15, ALE 0.07, PME 0.16, PLE 0.15, AME-AME 0.22, AME-ALE 0.27, PME-PME 0.22, PME-PLE 0.23, AME-PME 0.29, ALE-PLE 0.04, clypeus AME 0.12, clypeus ALE 0.11. Leg and pedipalp measurement: pedipalps 2.1 (0.7, 0.2, 0.5, -, 0.7), leg I 10.0 (2.9, 0.8, 2.4, 2.9, 1.0), leg II 9.7 (2.7, 0.9, 2.3, 2.8, 1.0), leg III 5.3 (1.7, 0.6, 1.0, 1.5, 0.5), leg IV 9.0 (2.6, 1.0, 2.1, 2.5, 0.8). Leg formula 1243. Chelicerae length 0.8.

Female (ACHLS8, Sabah). PL 2.7, PW 2.6, OL 4.1, OW 3.1. Eye diameters and interdistances: AME 0.16, ALE 0.05, PME 0.14, PLE 0.16, AME-AME 0.09, AME-ALE 0.25, PME-PME 0.09, PME-PLE 0.20, AME-PME 0.15, ALE-PLE 0.01, clypeus AME 0.11, clypeus ALE 0.10. Leg and pedipalpus measurement: pedipalp 2.7 (1.0, 0.3, 0.6, -, 0.8), leg I 11.0 (3.1, 0.7, 2.5, 3.7, 1.0), leg II 10.8 (3.1, 0.7, 2.3, 3.7, 1.0), leg III 5.6 (2.1, 0.7, 0.9, 1.3, 0.6), leg IV 10.1 (3.3, 0.9, 2.4, 2.7, 0.8). Leg formula 1243. Chelicerae length 0.9.

Coloration. Dorsal shield of prosoma greenish brown with dense white hairs at margin, partly radial markings, fovea indistinct. Sternum margin pale brown and sparsely hirsute, yellowish white towards the center, with three pairs of lateral humps and one less conspicuous posterior hump (Figs. 10 & 18). Labium, maxilla and chelicerae pale brown. Coxae greenish brown, coxa IV with tiny dark patches and denser white hairs towards the posterior. Legs greenish-brown, covered with thick white hairs on dorsum and on proximal segments, patellae I and II darker, tibia I and II with alternating bright and dark bands, metatarsus and tarsus brown, numerous short spines on proximal segments and long spines at distal segments. Dorsal opisthosoma greenish brown with white margins and faint horizontal bands, becoming darker posteriorly, sigilla black; ventrally with white anterior markings, median rectangular area bordered by broken longitudinal dark lines, six spots outlined by white hair; spinnerets brown. An apparent loss of green color and white markings can be observed in expired and ethanol-preserved specimens, turning yellowish brown in color. The dorsal abdominal markings appear to be more susceptible to fading towards the anterior end.

Variation. The body length of the all adult female specimens ranges between 6.0–6.8 mm. Abdominal colour variation was observed between individuals, which ranges from yellowish brown in younger individuals to dark green in ma-



Figs. 9−24. *Argiope chloreis*, female, Peninsular Malaysia. 9. Dorsal habitus. 10. Ventral habitus. 11. Epigyne, ventral view. 12. Posteroventral view. 13. Posterior view showing copulatory openings (arrows). 14. Lateral view. 15. Dorsal view. 16. Anterior view. Figs. 17−24. *Argiope chloreis*, female, Sabah, East Malaysia. 17. Dorsal habitus. 18. Ventral habitus. 19. Epigyne, ventral view. 20. Posteroventral view. 21. Posterior view showing copulatory openings (arrows). 22. Lateral view. 23. Dorsal view. 24. Anterior view. Abbreviations: FD, fertilization duct. Scale bars, 9–10, 17–18, 1 mm; 11–16, 19–24, 0.1 mm. Corresponding photographs of reproductive structures in Appendix 1.

ture and aged adults. Dorsally, the posterior half of the opisthosoma is always darker in tone than the anterior half; with some individuals from Borneo displaying a black-coloured anterior half (Figs. 8 & 17). Body setae also more hirsute in full adults. The epigynal structures of *A. chloreis* from Peninsular Malaysia and ACHLS8 from Sabah appeared to be fundamentally similar, i.e. thick rims, large depressions and a posterior plate that extends laterally into posterior lips.

Distribution. Malaysia, Southeast Sulawesi and Sumatra.

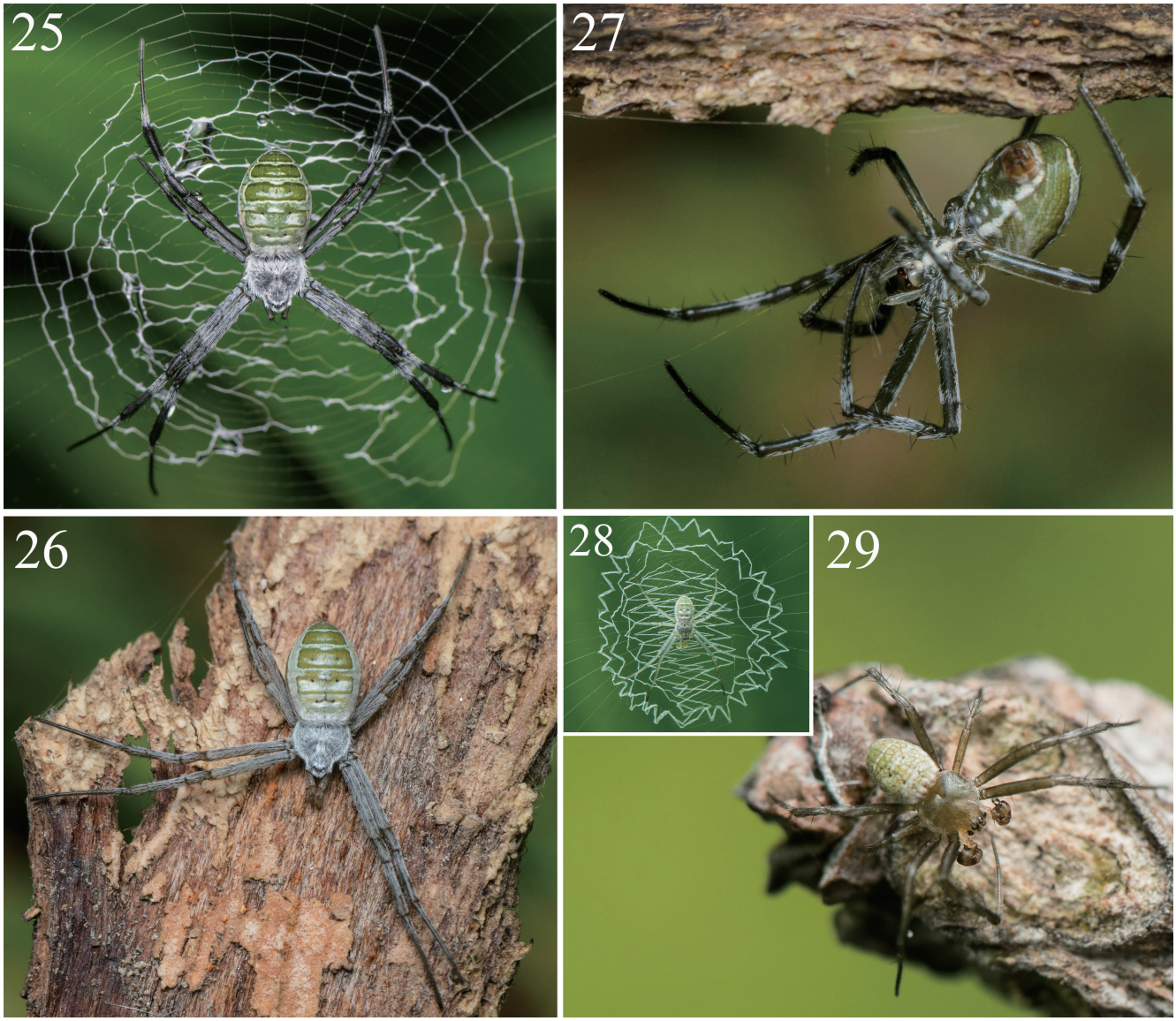
Biology. Specimens were found near rivers in disturbed forests. Females were found on tiny webs (with lace-type web decorations) built across the width of a blade of broad-leafed, herbaceous plants. Webs were occasionally in close proximity to one another. Adult and gravid females were observed in June and December in Peninsular Malaysia. Egg sacs were cone-shaped with a hexagonal base and constructed near the edges of webs. Males were not observed.

Argiope chloreides Chrysanthus 1961
(Figs. 25−41)

Argiope chloreides Chrysanthus 1961, p. 197, figs. 5−8

Argiope chloreis: Levi 1983, p. 292, figs. 141−143, 146, 147. Jäger & Krehenwinkel 2012, p. 95, fig. 1. Jäger 2012, p. 296, figs. 69−72. Jäger et al. 2012, p. 85, figs. 19–22.

Materials examined. PENINSULAR MALAYSIA: 1 ♀ (ACHL1; reg. MZC160416-01), Tokun Hill, Penang,

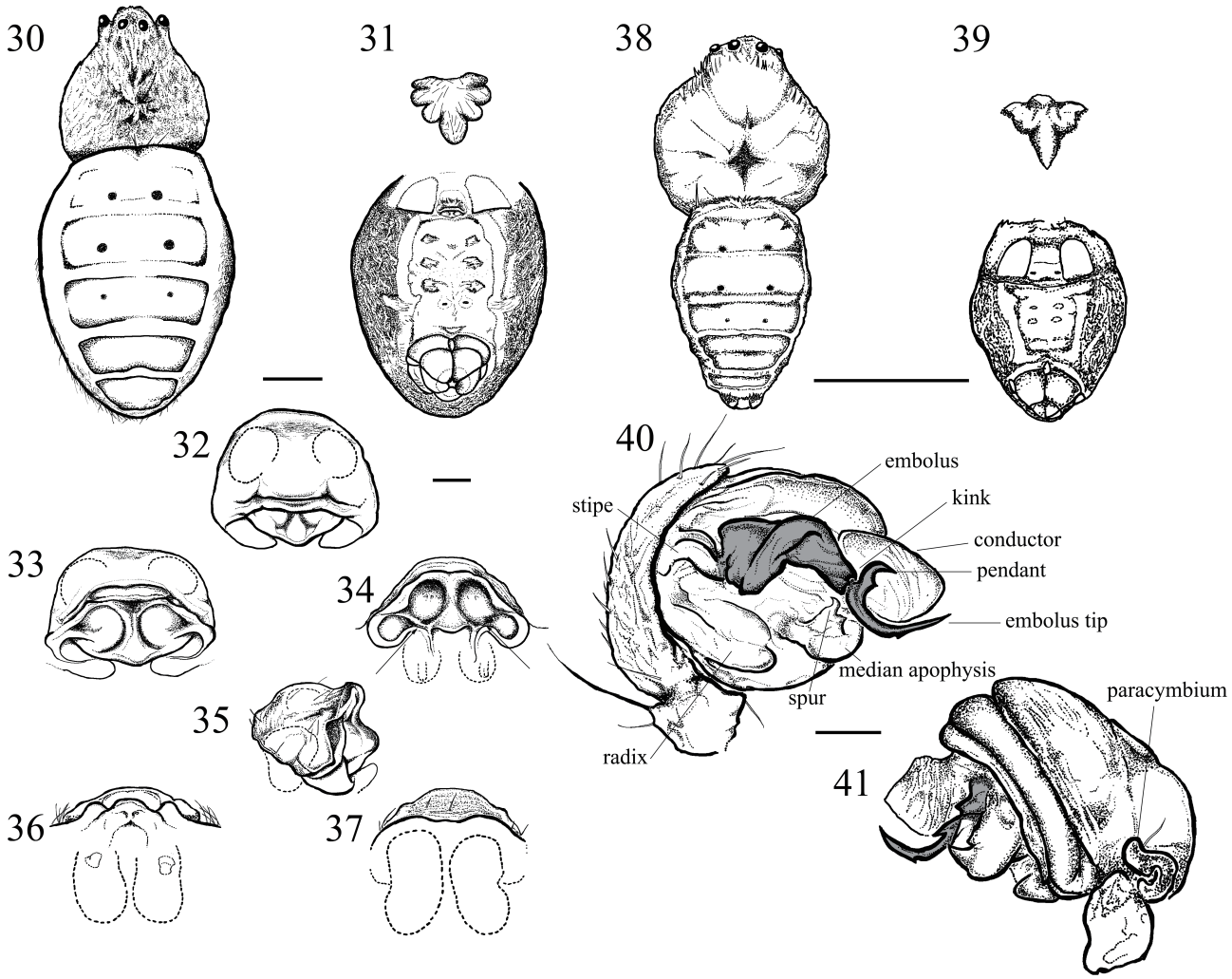


Figs. 25–29. *Argiope chloreides* Chrysanthus 1961. 25–27 female habitus; 28–29 male habitus. 25. Adult female (ACHL1) in a web with lace-type web decoration; 26. Adult female (ACHL2) with a less vibrant body coloration; 27. Photo showing ventral markings of the abdomen; 28. Penultimate molt of a male (ACHL3) with swollen palps; 29. Adult male (ACHL3) cleaning its fangs. Photographs by Tan J.

16.IV.2015, Chan Z. Y.; 1 ♀ (ACHL2; reg. MZC151216-01), Sungai Tekala, Semenyih, Selangor, 15.XII.2016, Chan Z. Y.; 1 ♂ (ACHL3; reg. MZC061018-01), Sungai Tua, Ulu Yam, Selangor, 6.X.2018 as penultimate instar, moulted 22.X.2018, Tan J.

Diagnosis. The male individual of *A. chloreides* displays unique greenish-brown coloration and an abdomen bearing five quadrilateral (rectangular to trapezoidal) markings not seen in other described males. In mesal view, the male copulatory organ (Fig. 40) shows (i) a coiled embolus connected to a long, curved embolus tip and an angled but shorter, indented pendant- together forming pincer-like structure towards the distal end; (ii) a fan-like conductor; and (iii) a long median apophysis with a non-filamentous spur on the upper surface. The female individuals of this species resemble those of *Argiope chloreis* Thorell 1977 in terms of size and the green coloration. Female individuals of *A. chloreides* also display a similar abdominal pattern of five quadrilateral markings which is absent in female *A. chloreis*. The epigyna of *A. chloreides* and *A. chloreis* are structurally different, with the former being trapezoidal and flatter in posterior view (Fig. 34).

Description. Male (ACHL2). PL 2.5, PW 2.3, OL 3.8, OW 2.7. Eye diameters and interdistances: AME 0.12, ALE 0.05, PME 0.11, PLE 0.13, AME-AME 0.11, AME-ALE 0.16, PME-PME 0.10, PME-PLE 0.30, AME-PME 0.19,



Figs. 30−41. *Argiope chloreides*, female. 30. Dorsal habitus. 31. Ventral habitus. 32. Epigyne, ventral view. 33. Posteroventral view. 34. Posterior view showing copulatory openings (arrows). 35. Lateral view. 36. Dorsal view. 37. Anterior view. Figs. 38−41. *Argiope chloreides*, male. 38. Dorsal habitus. 39. Ventral habitus. 40. Left palp, mesal view. 41. Prolateral view. Scale bars, 30−31, 38−39, 1 mm; 32−37, 40−41, 0.1 mm. Corresponding photographs of reproductive structures in Appendix 2.

ALE-PLE 0.03, clypeus AME 0.04, clypeus ALE 0.04. Palp and leg measurement: palp 0.8 (0.2, 0.1, 0.1, -, 0.4), leg I 4.7 (1.3, 0.4, 1.0, 1.7, 0.3), leg II 4.3 (1.3, 0.4, 1.0, 1.3, 0.3), leg III 2.2 (0.7, 0.2, 0.4, 0.5, 0.4), leg IV 3.6 (1.0, 0.2, 1.0, 0.9, 0.5). Leg formula 1243. Chelicerae length 0.2.

Coloration. Dorsal shield of prosoma brown and hirsute at margins, partly radial markings, fovea indistinct. Sternum margin brown and sparsely hirsute, with three pairs of indistinct lateral humps and one posterior hump. Labium, maxilla and chelicerae dark brown. Coxae dark brown, coxa I to IV with tiny dark patches and white setae. Legs brownish green, with thick white setae on dorsum and on proximal segments, metatarsus and tarsus brown, numerous short spines on proximal segments and long spines at distal segments. Dorsal opisthosoma with five distinct greenish-brown quadrilateral (rectangular to trapezoidal) markings and thick white margins, sigilla black; ventral median rectangular area bordered by continuous white longitudinal lines, and six spots outlined by white hair; spinnerets brown. The green coloration gradually fades when preserved in ethanol.

Description. Female (ACHL1). PL 2.3, PW 2.6, OL 4.0, OW 2.9. Eye diameters and interdistances: AME 0.11, ALE 0.06, PME 0.17, PLE 0.15, AME-AME 0.05, AME-ALE 0.26, PME-PME 0.13, PME-PLE 0.30, AME-PME 0.22, ALE-PLE 0.05, clypeus AME 0.04, clypeus ALE 0.11. Leg and pedipalp measurement: pedipalp 2.4 (0.9, 0.2, 0.6, -, 0.7), leg I 11.3 (3.5, 0.7, 2.9, 3.2, 1.0), leg II 10.8 (3.8, 0.8, 2.9, 3.2, 1.0), leg III 6.3 (2.3, 0.6, 1.2, 1.4, 0.8), leg IV 9.8 (3.2, 0.9, 2.1, 2.8, 0.8). Leg formula 1243. Chelicerae length 0.7.

Coloration. Dorsal shield of prosoma greyish white and densely hirsute, partly radial markings, fovea indistinct.

Sternum margin brown and sparsely hirsute, yellowish white towards the center, with three pairs of lateral humps and one less conspicuous posterior hump. Labium, maxilla and chelicerae brown. Coxae greenish brown, coxa I to IV with tiny dark patches and denser white hairs towards the posterior. Legs greyish black, covered with thick white hairs on dorsum and on proximal segments, femur I to IV with alternating bright and dark bands (only observable in alcohol preserved samples), metatarsus and tarsus dark brown, numerous short spines on proximal segments and long spines at distal segments. Dorsal opisthosoma with five distinct greenish-brown quadrilateral markings and thick white margins, sigilla black; ventral median rectangular area bordered by continuous white longitudinal lines, six spots and two crescent-shaped markings outlined by white hair; spinnerets brown. The loss of green coloration and white markings also observed in expired and ethanol-preserved specimens.

Variation. Another adult female with a more vibrant abdominal green color and darker-colored legs was observed (Fig. 25).

Distribution. Laos, Peninsular Malaysia and New Guinea.

Biology. Specimens were found on webs built across small shrubs and perimeter fences of disturbed forests. The webs of females were typically reinforced with lace-type web decorations although cruciform types with up to two arms were occasionally built by larger individuals. Adult females were observed in May and December. Females of *A. chloreides* were occasionally observed together with *A. chloreis* at the same location in Selangor, Peninsular Malaysia.

Notes on the molecular phylogeny of *Argiope*

The COI+COII+H3A tree (Fig. 2) used in the present study represented the best balance between phylogenetic resolution and the number of taxa analysed as only species with a complete set of DNA markers were used. This dataset accounted for approximately 36% of all described *Argiope* spp., or 50% of *Argiope* spp. reported from Southeast Asia and Australasia. For the most part this phylogenetic tree coincided with the one reported by Cheng & Kuntner (2014; 2015). *Argiope* spp. from Americas, Europe and Africa were genetically different and 'less-derived' than those from the Asia-Pacific. It would be worthwhile to investigate the genetic patterns of *Argiope* spp. with relatively extensive distributions, e.g., *A. bruennichi* (Wawer et al. 2017), *A. lobata* (Lindecke & Wall 2016), *A. trifasciata* (Levi 1983; 2004), and their influence on taxonomic inference. The paraphyly of *Argiope* with respect to *Gea* and *Neogea nocticolor* was also evident as reported by Tan et al. (2016). The current tree was able to provide insights into the morphology-based taxonomic grouping of *Argiope* spp. from earlier studies, notably those from Levi (1983) and Jäger (2012) who emphasized on species from the Western Pacific Region. Molecular results supported Levi's grouping of *A. aemula* and *A. catenulata* in the *A. aemula* species group based on their primitive features such as the swollen rims and lateral margins of the epigyne as well as the small, short embolus (Levi 1983). However, this disagrees with Levi's (1983) postulate that *A. reinwardti* is the most primitive *Argiope* in the region. The *A. aetherea* species group which was considered to be the most specialized was also supported (subclade A1), with most of the species reported from Southeast Asia, New Guinea and Australia. However, within the *A. anasuja* species group, *A. anasuja* itself was inferred to be genetically distant from *A. keyserlingi* and *A. mascordi* (Fig. 2), while *A. chloreis* was genetically very different from members of the *A. trifasciata* group composed mostly of species with elongated abdomen with folium pattern as well as species from the Americas (Levi 1983; 2004; Jäger 2012). The assessment of the *A. ocula*, *A. reinwardti*, *A. amoena* species groups was not possible based on the present data.

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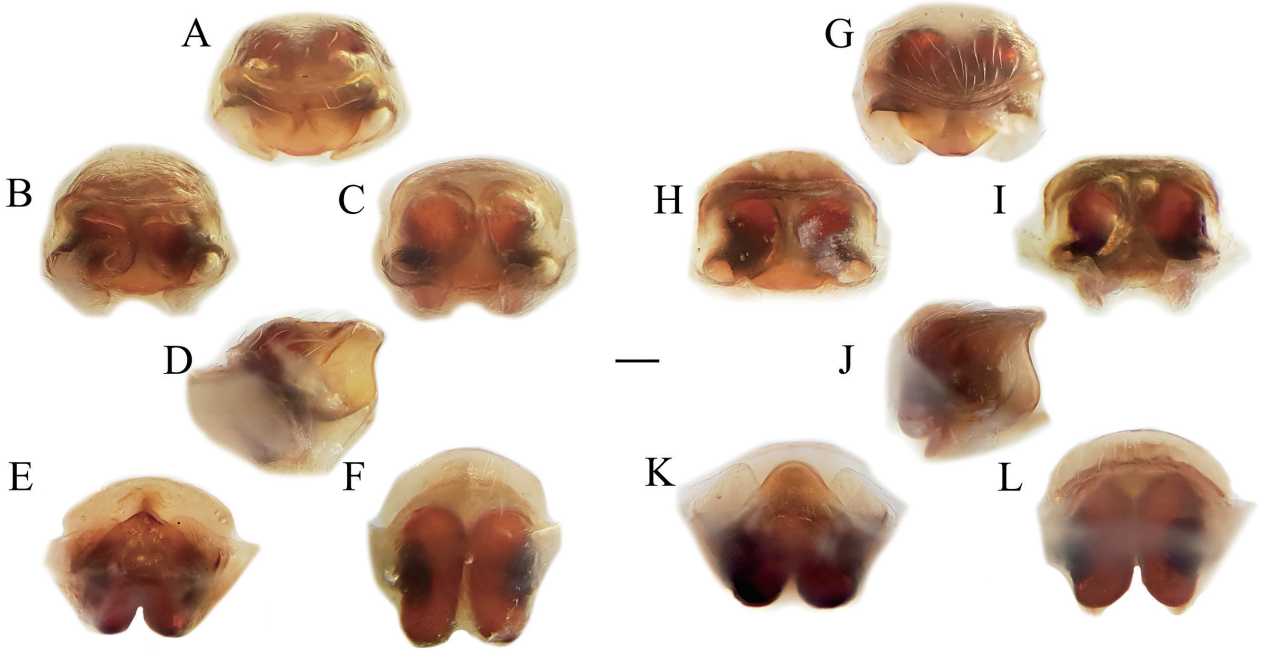
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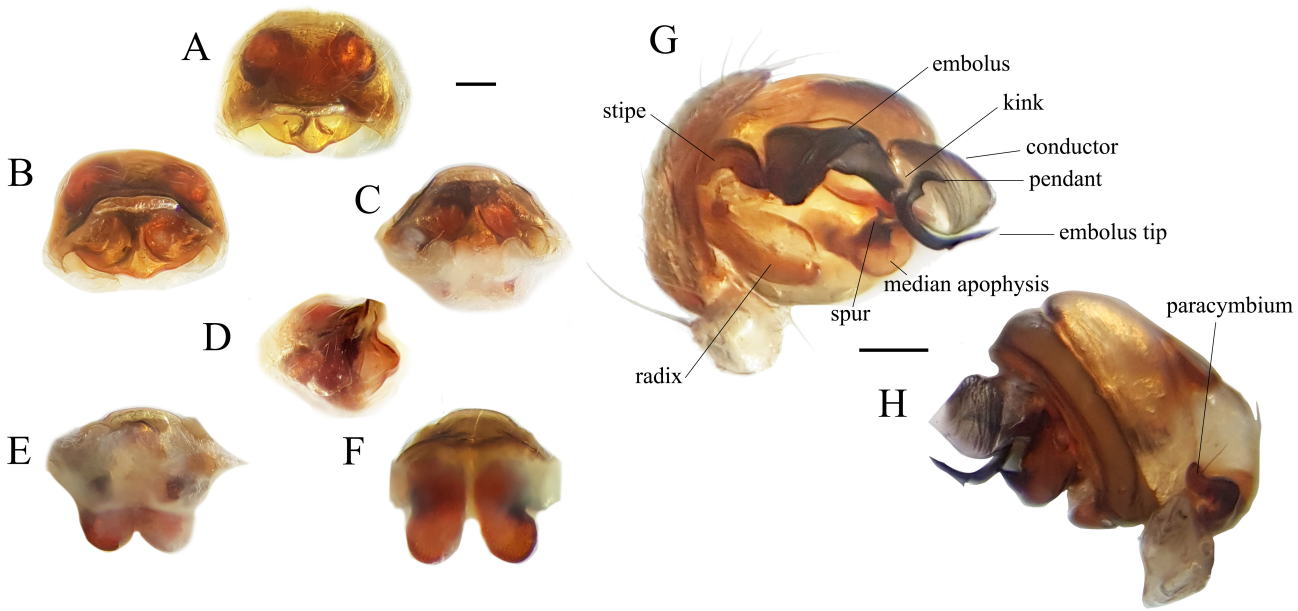
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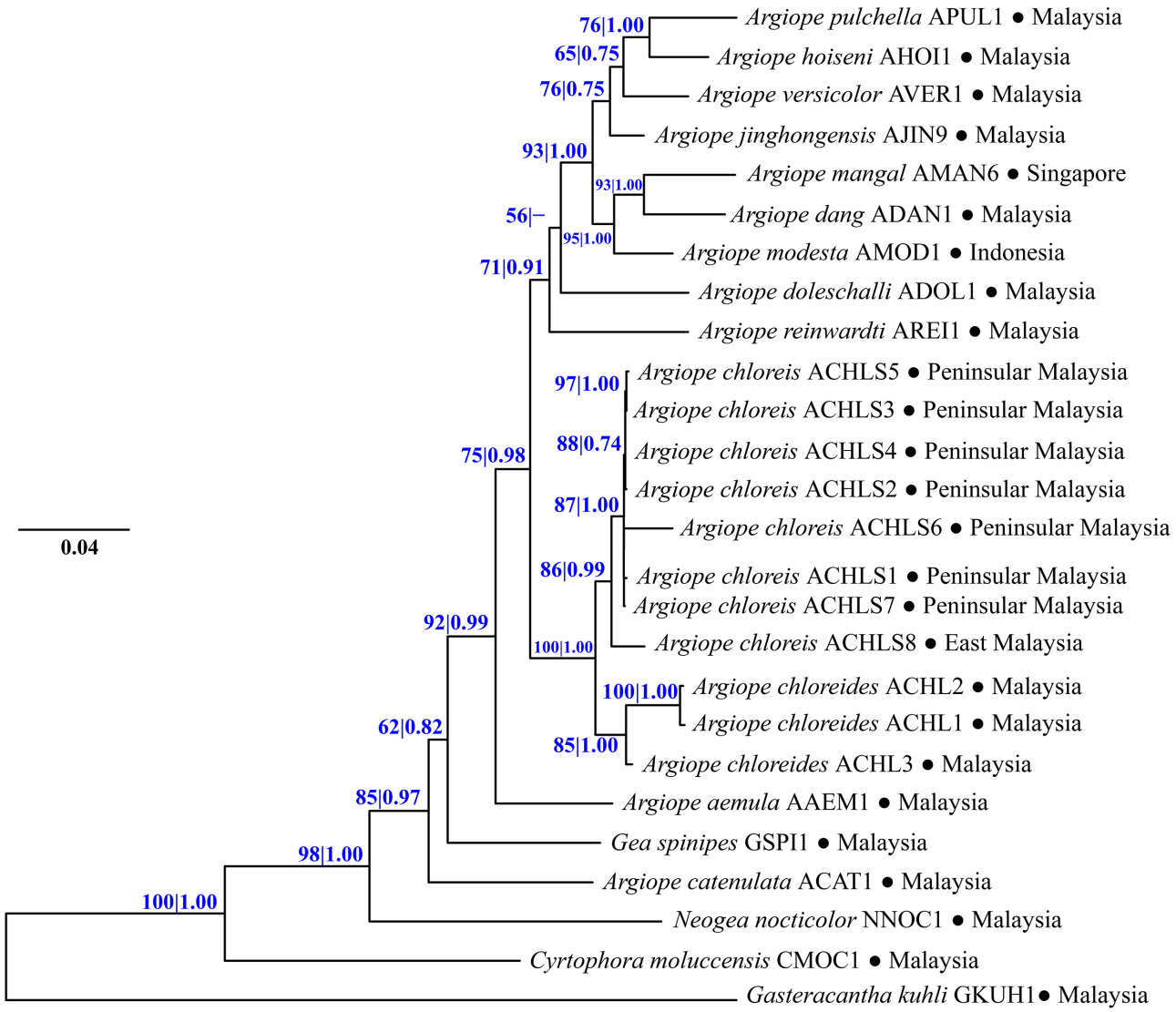
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Appendix 1. A–F. *Argiope chloreis*, female, Peninsular Malaysia. A, epigyne, ventral view; B, posteroventral view; C, posterior view; D, lateral view; E, dorsal view; F, anterior view. G–L. *Argiope chloreis*, female, Sabah, East Malaysia. G, epigyne, ventral view; H, posteroventral view; I, posterior view; J, lateral view; K, dorsal view; L, Anterior view. Scale bar, 0.1 mm.



Appendix 2. A–F. *Argiope chloreides*, female. A, epigyne, ventral view; B, posteroventral view; C, posterior view; D, lateral view; E, dorsal view; F, anterior view. G–H. *Argiope chloreides*, male. G, left palp, mesal view; H, prolateral view. Scale bars, 0.1 mm.



Appendix 3. Maximum Likelihood tree based on the concatenated 16S+CO1+CO2+H3A+18S dataset. Numeric values at nodes arranged in an order of Ultrafast ML bootstrap support/Bayesian posterior probability.

Appendix 4. Uncorrected "p" distance (%) between different species of *Argiope* based on the COI dataset.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
1 *A. aurocincta*																																																					
2 *A. luzona*	8.0																																																						
3 *A. flavipalpis*	11.0	12.4																																																				
4 *A. amoena*	12.2	15.6	13.4																																																			
5 *A. ahngeri*	10.3	16.0	12.5	16.5																																																			
6 *A. aculа*	8.6	14.4	10.2	14.4	13.4																																																	
7 *A. submaronica*	9.9	14.6	11.0	15.9	15.7	12.1																																																
8 *A. reinwardti*	10.3	11.5	13.3	15.2	14.0	12.3	14.6																																															
9 *A. reinwardti*	9.0	10.9	14.8	15.7	14.4	11.9	14.0	4.2																																													
10 *A. levii*	7.8	13.4	6.0	14.6	12.3	10.9	12.3	13.1	14.0																																												
11 *A. boesenbergi*	8.0	11.6	10.9	12.3	13.1	12.5	14.2	12.7	13.1	10.2																																											
12 *A. picta*	11.1	13.6	12.7	15.9	13.1	10.7	13.1	12.1	13.3	12.9	11.1																																										
13 *A. catenulata*	9.9	13.2	13.0	15.5	13.1	12.3	13.4	13.6	12.3	11.7	6.5																																										
14 *A. blanda*	9.9	14.4	11.4	14.6	13.2	11.5	11.3	12.7	12.7	11.9	11.9	9.3	9.6																																							
15 *A. argentata*	10.4	14.8	9.6	14.0	12.9	11.1	10.7	12.3	13.1	11.9	12.1	11.1	11.5	8.3																																							
16 *A. ocyaloides*	9.1	12.1	11.1	14.6	13.3	12.9	13.4	12.1	12.3	12.1	12.1	12.1	11.0	10.8	11.9																																						
17 *A. ranonufensis*	10.4	11.2	10.3	12.7	12.1	11.7	12.3	10.6	11.5	11.5	10.2	10.6	10.4	10.4	11.0	6.3																																						
18 *A. pulchella*	11.6	11.8	14.1	16.1	16.3	14.0	13.8	11.5	11.7	14.6	13.4	11.9	9.6	13.2	13.4	12.1	11.5																																						
19 *A. aemula*	8.4	13.0	12.1	13.6	11.7	11.7	12.7	10.4	11.3	11.1	10.4	9.9	9.4	11.5	10.9	10.2	8.8	10.9																																						
20 *A. chloreides* (ACHL3)	9.8	14.1	11.2	13.6	12.9	11.7	10.2	11.9	12.7	11.5	11.7	9.5	9.8	9.8	10.0	10.2	9.8	10.9	8.8																																						
21 *A. chloreides* (ACHL2)	8.9	13.9	10.3	13.1	12.1	11.3	10.0	11.3	12.1	11.3	10.9	11.1	10.2	8.6	8.8	10.2	9.6	10.9	7.9	1.9																																						
22 *A. chloreides* (ACHL1)	9.4	13.1	10.7	13.2	12.1	11.7	10.6	10.9	12.1	11.5	11.5	11.5	10.6	9.0	9.2	10.0	9.4	11.3	8.3	1.9	0.8																																					
23 *A. amasyja*	9.1	11.8	10.9	12.9	12.1	12.9	13.6	10.4	10.9	10.6	10.9	12.1	11.5	12.5	10.7	12.5	11.3	12.3	10.6	11.9	11.3	11.1																																				
24 *A. doleschalli*	10.7	13.8	14.4	14.0	15.5	12.3	12.9	11.5	11.5	14.0	12.5	12.5	10.7	11.7	10.9	12.3	11.9	10.0	9.6	10.7	10.0	10.4	10.6																																				
25 *A. hoiseni*	10.8	10.6	14.5	16.1	16.1	13.4	13.6	12.9	12.5	14.0	15.0	13.1	10.0	13.1	13.1	11.9	11.9	10.8	10.7	11.9	11.9	12.3	12.9	11.9																																				
26 *A. katerina*	8.1	10.2	10.7	14.8	14.0	12.3	11.5	10.4	10.9	10.4	9.6	11.5	9.4	10.9	12.1	10.2	10.2	9.8	10.6	9.6	9.6	10.0	10.6	9.8	12.1																																				
27 *A. dietrichae*	9.5	9.9	11.9	15.2	14.6	12.3	13.2	10.6	11.1	11.7	10.7	11.3	10.0	12.1	12.3	11.3	11.2	10.4	11.5	10.7	10.7	10.7	11.1	11.3	10.4	12.7	2.3																																			
28 *A. mascordi*	9.6	11.0	9.8	13.2	14.2	12.3	11.9	9.8	10.9	10.2	10.9	12.3	10.9	11.3	11.1	10.8	10.6	9.8	10.7	10.7	10.7	10.7	11.1	10.7	11.7	7.3	8.4																																			
29 *A. keyserlingi*	11.3	11.2	11.2	15.2	14.0	12.3	12.7	12.1	12.3	11.7	12.1	11.7	11.3	10.6	11.3	11.3	10.8	10.7	11.9	11.7	11.7	11.3	10.9	11.7	11.5	9.2	10.4	6.5																																			
30 *A. dang*	11.3	12.3	12.1	14.6	12.5	12.1	12.1	11.7	12.1	12.5	11.3	10.2	11.3	11.1	10.7	12.1	11.1	10.6	9.8	10.6	9.8	10.2	10.4	11.1	12.5	10.7	11.5	11.5	11.5																																			
31 *A. radon*	10.3	12.7	14.0	14.8	12.7	12.1	13.1	11.3	11.7	13.8	11.3	8.5	11.9	10.9	11.9	11.7	10.0	11.5	10.4	11.7	11.1	11.5	11.5	11.7	12.3	10.2	10.7	11.7	11.3	10.0																																			
32 *A. mangal*	8.9	12.3	13.9	14.2	14.4	11.3	12.7	10.6	10.7	12.7	12.3	10.7	10.7	11.7	11.7	12.7	11.7	9.8	9.2	11.7	9.8	10.9	10.6	11.3	11.3	11.1	9.8	9.8	10.0	10.2	9.6	9.6																																			
33 *A. chloreis* (ACHLS8)	8.9	14.8	11.7	14.6	13.4	11.5	12.5	11.5	11.5	10.4	11.5	10.9	9.8	11.3	10.4	11.3	10.2	11.5	9.2	7.9	8.3	8.6	10.7	10.9	11.5	10.4	11.5	10.4	11.7	11.1	11.1	10.6																																			
34 *A. chloreis* (ACHLS4)	10.3	12.2	10.0	13.6	12.9	10.4	11.7	11.1	11.1	9.6	10.2	9.9	8.8	11.1	10.0	10.4	8.6	10.7	8.3	7.9	7.9	8.3	11.3	10.2	10.9	9.6	10.9	9.0	10.9	10.9	10.2	11.1	10.0	4.0																																			
35 *A. chloreis* (ACHLS2)	10.3	12.2	10.0	13.6	12.9	10.4	11.7	11.1	11.1	9.6	10.2	9.9	8.8	11.1	10.0	10.4	8.6	10.7	8.3	7.9	7.9	8.3	11.3	10.2	10.9	9.6	10.9	9.0	10.9	10.9	10.2	11.1	10.0	4.0	0.0																																			
36 *A. chloreis* (ACHLS3)	10.3	12.2	10.0	13.6	12.9	10.4	11.7	11.1	11.1	9.6	10.2	9.9	8.8	11.1	10.0	10.4	8.6	10.7	8.3	7.9	7.9	8.3	11.3	10.2	10.9	9.6	10.9	9.0	10.9	10.9	10.2	11.1	10.0	4.0	0.0	0.4																																			
37 *A. chloreis* (ACHLS1)	10.3	12.2	9.5	13.2	12.5	10.0	11.5	10.7	10.7	9.2	9.8	9.5	9.2	10.7	9.6	10.4	8.3	11.1	8.6	8.3	7.9	8.3	10.9	10.6	11.3	9.2	10.6	8.6	10.6	10.6	10.7	10.0	4.4	0.4	0.4	0.4																																			
38 *A. chloreis* (ACHLS6)	10.3	12.3	10.7	13.4	13.1	10.4	12.3	10.7	10.7	10.0	10.4	9.9	9.6	11.5	10.2	10.4	8.8	11.1	8.8	8.1	8.4	8.4	11.3	10.9	11.7	10.0	10.9	9.4	11.3	10.6	11.3	9.8	4.2	0.8	0.8	0.8	0.8																																			
39 *A. chloreis* (ACHLS5)	10.3	12.3	10.7	13.4	13.1	10.4	12.3	10.7	10.7	10.0	10.4	9.9	9.6	11.5	10.2	10.4	8.8	11.1	8.8	8.1	8.4	8.4	11.3	10.9	11.7	10.0	10.9	9.4	11.3	10.6	11.3	9.8	4.2	0.8	0.8	0.8	0.8	0.0																																			
40 *A. chloreis* (ACHLS7)	10.3	12.8	10.7	13.4	13.1	10.4	12.1	10.7	10.7	10.0	10.4	9.9	9.6	11.5	10.2	10.8	8.8	11.1	8.8	8.1	8.8	8.1	11.3	10.9	11.7	10.0	10.9	9.4	11.3	10.6	11.3	10.2	4.2	0.8	0.8	0.8	0.4	0.4																																			
41 *A. minuta*	9.0	11.9	12.5	14.4	15.5	10.0	12.1	9.6	10.4	12.1	11.5	10.7	10.7	12.1	11.3	11.0	9.4	9.8	9.6	10.9	10.2	10.2	10.7	10.7	11.1	8.8	8.6	8.4	8.6	9.6	9.6	9.2	9.4	9.2	11.1	9.6	9.6	9.2	10.0	10.0	10.0																																			
42 *A. aetheroides*	9.0	8.9	12.4	14.6	13.6	10.4	11.7	9.8	9.4	10.7	11.1	10.5	10.4	10.9	10.7	10.2	10.0	10.0	8.8	9.2	9.2	9.2	10.0	9.0	9.4	8.3	8.6	8.4	8.6	9.6	9.6	9.2	9.4	7.7	7.7	7.7	7.3	8.1	8.1	8.1	7.5																																			
43 *A. jinghongensis*	9.9	9.2	11.3	13.2	14.2	10.6	12.1	10.4	10.4	11.1	11.1	11.1	10.2	11.3	9.4	10.2	9.6	8.3	8.8	9.4	9.4	9.8	9.8	9.0	7.9	8.8	9.4	7.3	9.2	10.6	10.0	9.4	9.2	7.5	7.5	7.5	7.1	7.9	7.9	7.9	7.1	4.8																																			
44 *A. aetherea*	7.8	11.7	13.3	13.6	14.6	10.9	12.5	11.5	10.9	12.5	11.5	11.5	11.3	11.3	11.3	12.5	11.2	10.4	10.6	10.4	10.6	10.4	11.5	11.5	10.9	10.9	10.4	11.1	9.8	9.8	7.5	8.1	9.4	7.9	7.9	7.9	8.3	8.3	8.3	7.5	7.1	6.5	8.1	6.0	5.8	4.0																																			
45 *A. modesta*	8.1	9.8	11.7	14.0	13.1	10.9	11.3	11.1	10.9	11.3	10.9	10.7	10.2	10.4	10.4	9.8	10.2	9.4	10.2	8.8	8.4	8.8	9.4	9.4	10.2	8.4	9.0	9.4	9.8	8.1	9.2	8.1	9.4	8.6	8.6	8.6	9.0	9.4	9.4	9.4	8.4	7.9	7.5	6.5																																			
46 *A. modesta*	7.3	8.8	11.6	13.8	12.1	10.7	10.9	10.4	10.0	10.4	10.2	10.3	10.6	9.6	9.6	8.6	9.2	10.2	10.2	9.4	9.0	9.0	8.6	9.8	10.0	8.3	8.4	9.0	9.8	7.5	8.3	8.3	10.0	8.4	8.4	8.4	8.6	8.8	8.8	8.8	9.2	7.5	7.3	6.7	2.9																																			
47 *A. macrochaera*	8.6	10.7	10.9	13.4	12.7	11.7	11.9	10.9	11.7	10.9	9.2	9.3	9.8	10.4	9.4	10.4	9.6	10.4	8.8	10.7	10.2	10.6	7.9	9.6	11.1	9.0	9.6	8.4	9.0	8.8	7.5	9.4	9.4	8.6	8.6	8.6	8.3	9.0	9.0	9.0	7.7	7.1	6.9	8.8	8.3	6.7																																			
48 *A. versicolor*	9.8	11.1	11.5	13.8	14.0	11.5	10.9	10.7	11.5	12.1	10.2	9.3	8.8	10.7	9.2	10.0	9.4	9.0	8.4	8.6	8.6	9.0	8.4	8.4	10.4	7.5	8.1	8.1	9.4	7.9	7.9	7.9	8.3	7.5	7.5	7.5	7.9	8.3	8.3	8.3	7.5	7.1	6.5	8.1	6.0	5.8	4.0																																			
49 *A. lobata*	9.0	16.8	10.4	15.0	10.2	12.1	14.0	14.6	15.2	11.5	11.7	12.3	11.9	12.3	13.1	13.1	11.5	15.5	12.9	13.2	13.2	13.4	12.1	14.0	14.6	12.5	13.4	13.2	13.2	12.3	12.5	12.7	13.2	12.3	12.3	12.3	11.9	12.5	12.5	12.5	13.2	12.7	13.4	14.0	12.5	11.9	11.9	12.3																																			
50 *A. australis*	8.6	14.6	11.6	14.0	10.7	10.9	12.7	13.6	13.2	12.1	11.5	12.3	11.5	12.3	11.1	10.2	10.6	13.1	11.9	10.6	10.6	10.7	12.1	13.6	12.7	12.3	13.1	12.3	12.5	11.7	13.1	11.5	12.1	10.4	10.4	10.6	10.6	10.9	10.9	10.9	10.7	11.7	11.5	6.3																																			
51 *A. trifasciata*	9.0	13.4	11.0	15.4	11.9	11.7	13.2	14.4	13.8	11.7	12.1	11.5	11.3	13.1	11.9	11.0	12.3	12.9	11.9	11.9	12.3	12.3	12.1	12.1	13.4	10.6	12.1	12.7	13.1	10.6	11.3	11.1	12.3	10.6	10.6	10.6	10.9	10.9	11.3	12.3	11.7	11.3	11.9	9.8	10.0	10.0	11.5	11.7																																			
52 *A. protensa*	9.5	14.6	9.7	15.4	11.7	12.3	14.2	13.2	13.1	11.5	11.3	13.5	11.9	12.5	11.7	12.1	11.5	13.1	11.5	12.3	12.3	12.5	11.7	12.1	11.5	13.1	14.2	11.5	12.3	11.9	13.2	13.8	13.4	14.2	11.7	10.0	10.0	9.6	10.0	10.0	10.0	13.2	11.9	11.1	13.6	11.7	10.9	10.9	11.5	10.9	10.9	10.7																																			
53 *A. aurantia*	9.1	15.4	9.1	15.2	10.9	11.9	13.2	13.8	14.2	10.0	11.3	12.7	12.3	11.5	11.3	11.9	11.1	14.4	12.3	11.9	11.7	12.1	11.9	14.0	13.6	10.9	11.7	11.5	12.9	12.3	11.5	12.9	11.3	10.6	10.6	10.2	10.7	10.7	10.7	13.2	11.7	12.5	13.1	12.1	11.1	11.3	12.1	9.6	11.7	12.1	8.4																																		
54 *A. bruennichi*	9.0	14.3	9.9	15.0	11.5	11.9	11.3	12.9	12.9	10.2	11.7	11.7	11.5	11.5	11.9	11.3	12.1	13.2	10.9	11.1	11.1	11.1	11.3	12.9	13.4	10.4	11.1	11.3	12.3	12.3	11.5	11.7	11.3	10.9	11.3	11.3	11.3	11.7	11.3	10.9	11.5	10.6	9.6	10.7	10.7	10.2	10.7	10.7	11.3	8.8	7.5																																		

Appendix 5. Uncorrected "p" distance (%) between different species of *Argiope* based on the COII dataset.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	*A. ocula*																																								
2	*A. anasuja*	13.77																																							
3	*A. amoena*	15.70	13.77																																						
4	*A. boesenbergi*	12.80	12.56	11.84																																					
5	*A. reinwardti*	14.01	12.80	14.01	12.08																																				
6	*A. aurocincta*	12.08	13.04	14.25	11.35	10.14																																			
7	*A. bruennichi*	10.63	13.53	16.18	11.35	11.59	10.63																																		
8	*A. aemula*	14.73	11.11	11.59	12.32	13.29	14.98	14.01																																	
9	*A. ocyaloides*	14.49	12.32	12.56	11.11	12.56	11.84	10.63	10.14																																
10	*A. catenulata*	12.56	12.56	13.04	11.35	12.56	11.84	10.63	13.77	11.59																															
11	*A. protensa*	11.59	14.01	14.73	12.56	10.87	11.35	9.42	13.29	11.35	10.63																														
12	*A. chloreis* (ACHLS8)	14.01	11.59	12.32	12.08	12.32	13.53	12.80	10.39	10.87	10.63	12.32																													
13	*A. chloreis* (ACHLS4)	14.01	12.32	11.35	11.59	11.59	13.29	11.11	9.90	9.90	10.39	11.11	3.86																												
14	*A. chloreis* (ACHLS5)	14.01	12.32	11.35	11.59	11.59	13.29	11.11	9.90	9.90	10.39	11.11	3.86	0.00																											
15	*A. chloreis* (ACHLS3)	14.01	12.32	11.35	11.59	11.59	13.29	11.11	9.90	9.90	10.39	11.11	3.86	0.00	0.00																										
16	*A. chloreis* (ACHLS2)	14.01	12.32	11.35	11.59	11.59	13.29	11.11	9.90	9.90	10.39	11.11	3.86	0.00	0.00	0.00																									
17	*A. chloreis* (ACHLS7)	14.25	12.56	11.59	11.84	11.84	13.53	11.35	10.14	10.14	10.63	11.35	4.11	0.24	0.24	0.24	0.24																								
18	*A. chloreis* (ACHLS6)	14.25	12.56	11.59	11.84	11.84	13.53	11.35	10.14	10.14	10.63	11.35	4.11	0.24	0.24	0.24	0.24	0.00																							
19	*A. chloreis* (ACHLS1)	14.25	12.56	11.59	11.84	11.84	13.53	11.35	10.14	10.14	10.63	11.35	4.11	0.24	0.24	0.24	0.24	0.00	0.00																						
20	*A. doleschalli*	11.11	11.84	12.08	9.66	13.04	11.59	10.39	11.59	12.56	11.59	11.59	10.39	10.14	10.14	10.14	10.14	10.39	10.39	10.39																					
21	*A. chloreides* (ACHL3)	12.80	12.08	13.53	12.32	10.39	11.84	9.90	12.08	10.63	9.90	8.94	9.18	8.21	8.21	8.21	8.21	8.45	8.45	8.45	10.87																				
22	*A. chloreides* (ACHL1)	11.63	11.16	13.10	12.13	10.40	11.38	9.21	11.40	10.18	9.45	8.47	8.24	8.25	8.25	8.25	8.25	8.49	8.49	8.49	10.43	1.21																			
23	*A. chloreides* (ACHL2)	11.84	11.35	13.04	12.32	10.39	11.59	9.42	11.35	9.90	9.18	8.70	8.21	8.21	8.21	8.21	8.21	8.45	8.45	8.45	10.39	0.97	0.24																		
24	*A. katherina*	14.73	12.56	12.80	12.80	11.35	12.08	13.04	11.59	11.59	13.53	14.01	12.32	11.59	11.59	11.59	11.59	11.84	11.84	11.84	10.39	12.80	11.85	12.08																	
25	*A pulchella*	13.53	11.59	12.56	9.90	10.87	11.59	12.80	11.11	12.32	11.84	13.04	11.59	11.35	11.35	11.35	11.35	11.59	11.59	11.59	10.39	11.84	11.65	11.59	9.66																
26	*A. mascordi*	13.77	13.29	12.56	12.32	12.08	12.32	13.29	12.08	10.39	11.84	11.59	10.39	11.59	11.59	11.59	11.59	11.84	11.84	11.84	11.35	10.39	10.41	10.14	11.84	11.11															
27	*A. keyserlingi*	13.04	12.08	11.11	11.84	11.11	11.84	12.08	10.63	8.94	12.08	11.35	9.90	9.90	9.90	9.90	9.90	10.14	10.14	10.14	9.18	9.90	9.69	9.42	9.66	9.66	5.31														
28	*A. luzona*	12.56	13.04	12.32	11.11	9.42	12.08	9.42	12.32	10.87	12.08	11.84	12.80	11.84	11.84	11.84	11.84	12.08	12.08	12.08	10.87	11.11	11.14	11.11	9.66	7.49	10.63	8.45													
29	*A. perforata*	12.08	11.59	13.04	11.35	10.63	12.08	11.11	11.11	10.87	10.39	11.35	11.35	11.35	11.35	11.35	11.35	11.59	11.59	11.59	9.18	10.39	10.17	9.90	9.90	9.66	9.66	9.90	8.45												
30	*A. minuta*	13.04	11.59	10.39	10.14	10.14	11.11	10.63	9.90	9.90	11.35	11.59	10.14	9.18	9.18	9.18	9.18	9.42	9.42	9.42	8.94	8.70	8.98	8.94	7.73	8.45	9.18	8.45	9.18	7.97											
31	*A. modesta*	11.11	11.84	12.08	10.14	10.87	9.42	10.63	11.84	10.39	9.90	11.35	10.14	9.42	9.42	9.42	9.42	9.66	9.66	9.66	8.45	9.66	9.20	9.42	9.18	8.70	9.42	8.94	9.18	8.45	7.73										
32	*A. aetherea*	12.32	11.35	12.08	10.39	10.63	11.59	11.35	9.66	9.42	11.11	12.08	9.66	9.42	9.42	9.42	9.42	9.66	9.66	9.66	8.70	9.90	9.93	9.66	8.94	9.42	9.42	7.97	8.94	7.00	7.49	5.31									
33	*A. radon*	10.63	10.87	10.39	11.11	11.11	12.32	11.11	10.87	10.63	11.59	11.11	11.11	10.14	10.14	10.14	10.14	10.39	10.39	10.39	8.94	11.11	10.42	10.63	10.39	9.66	10.14	8.45	8.21	8.70	8.70	7.49	8.45								
34	*A. picta*	10.63	10.39	9.90	10.63	11.11	12.32	10.63	10.63	10.14	11.11	11.35	10.63	9.66	9.66	9.66	9.66	9.90	9.90	9.90	8.45	10.63	9.93	10.14	9.90	9.18	9.66	7.97	7.73	8.21	8.21	7.00	7.97	0.48							
35	*A. dang*	10.87	10.87	12.08	10.87	10.14	12.08	9.90	10.39	8.45	10.14	10.39	9.42	8.94	8.94	8.94	8.94	9.18	9.18	9.18	8.21	9.18	8.97	8.70	8.94	9.42	9.42	8.21	7.49	7.73	7.49	7.49	6.04	5.80	5.31						
36	*A. mangal*	12.32	11.84	11.84	12.32	11.11	12.08	10.39	10.14	9.42	10.63	11.35	10.87	9.90	9.90	9.90	9.90	10.14	10.14	10.14	9.42	10.14	9.93	9.66	9.66	9.66	9.90	7.25	8.21	7.00	8.94	8.94	8.21	7.25	7.00	7.97				
37	*A. versicolor*	11.35	10.63	11.59	10.87	10.63	10.87	9.66	10.63	9.42	9.66	9.90	10.63	9.90	9.90	9.90	9.90	10.14	10.14	10.14	8.94	8.70	8.24	7.97	8.94	7.25	9.66	7.73	7.49	7.25	7.73	7.25	6.76	7.73	7.25	7.00	7.25				
38	*A. hoiseni*	10.87	11.11	11.59	11.11	10.63	10.87	9.66	10.63	9.90	9.66	9.90	10.63	9.90	9.90	9.90	9.90	10.14	10.14	10.14	8.45	9.18	8.72	8.45	8.45	7.25	9.66	7.25	7.00	7.25	7.73	7.25	6.76	7.25	6.76	6.52	6.76	0.48			
39	*A. aetheroides*	12.08	10.87	13.29	12.32	9.90	11.59	10.63	10.39	10.39	10.87	11.59	11.35	11.11	11.11	11.11	11.11	11.35	11.35	11.35	9.18	9.66	9.45	9.18	8.94	7.25	10.14	8.21	7.97	6.76	8.21	7.73	6.52	8.45	7.97	7.73	7.25	5.31	4.83		
40	*A. jinghongensis*	10.63	10.87	12.32	10.87	9.90	10.39	10.14	11.11	10.87	11.59	10.63	11.84	11.11	11.11	11.11	11.11	11.35	11.35	11.35	8.94	9.90	9.68	9.66	7.97	8.45	9.90	8.45	7.00	6.76	7.97	6.76	6.04	8.21	7.73	7.25	7.00	6.52	6.04	4.35	

Appendix 6. Uncorrected "p" distance (%) between different species of *Argiope* based on the 16S+COI+COII+H3A+18S dataset.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	*A. catenulata*																						
2	*A. reinwardti*	6.81																					
3	*A. doleschalli*	5.93	5.69																				
4	*A. aemula*	5.85	5.92	5.04																			
5	*A. chloreis* (ACHL2)	5.20	5.23	4.66	4.54																		
6	*A. chloreis* (ACHL1)	5.31	5.16	4.73	4.62	0.27																	
7	*A. chloreis* (ACHL3)	5.39	5.54	4.85	4.54	1.85	1.85																
8	*A. chloreis* (ACHLS6)	5.08	5.08	4.96	4.69	2.12	2.16	3.19															
9	*A. chloreis* (ACHLS8)	5.31	5.58	4.89	4.58	3.23	3.31	2.46	2.46														
10	*A. chloreis* (ACHLS5)	5.16	5.27	4.77	4.39	3.15	3.23	1.92	1.54	1.65													
11	*A. chloreis* (ACHLS3)	5.08	5.35	4.69	4.31	3.15	3.23	1.85	1.54	1.58	0.08												
12	*A. chloreis* (ACHLS2)	5.08	5.35	4.69	4.31	3.12	3.23	1.85	1.54	1.58	0.15	0.08											
13	*A. chloreis* (ACHLS4)	5.04	5.31	4.66	4.27	3.12	3.19	1.81	1.50	1.54	0.12	0.04	0.04										
14	*A. chloreis* (ACHLS1)	5.27	5.31	4.89	4.46	3.31	3.31	1.85	1.42	1.65	0.23	0.23	0.27	0.23									
15	*A. chloreis* (ACHLS7)	5.23	5.27	4.85	4.43	3.19	3.35	1.81	1.46	1.62	0.23	0.23	0.23	0.19	0.12								
16	*A. mangal*	6.20	5.23	5.12	5.46	5.19	5.16	5.00	5.00	5.27	4.96	4.96	5.00	4.96	4.93	5.04							
17	*A. pulchella*	5.39	5.43	4.96	5.39	5.27	5.35	5.31	5.31	5.35	5.19	5.12	5.16	5.12	5.19	5.23	4.62						
18	*A. dang*	6.08	5.23	4.96	4.92	4.77	4.89	4.96	4.89	5.04	4.85	4.77	4.77	4.73	4.89	4.85	4.00	4.85					
19	*A. modesta*	5.43	5.23	4.46	5.00	4.16	4.23	4.35	4.39	4.46	4.27	4.19	4.12	4.16	4.39	4.35	3.92	4.23	3.54				
20	*A. hoiseni*	5.43	5.54	5.19	5.50	4.92	5.04	5.16	4.89	5.08	4.92	4.85	4.85	4.81	5.04	5.00	4.35	3.81	4.50	3.89			
21	*A. versicolor*	5.20	5.31	4.39	4.62	4.19	4.31	4.58	4.19	4.50	4.31	4.23	4.23	4.19	4.42	4.39	4.00	4.08	3.89	3.23	3.08		
22	*A. jinghongensis*	5.54	5.00	4.38	4.54	4.42	4.50	4.66	3.92	4.54	4.12	4.04	4.04	4.00	4.16	4.12	3.85	3.96	4.12	3.12	3.23	2.81	